THE

CHEMICAL NEWS

AND

JOURNAL OF INDUSTRIAL SCIENCE.

WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE."

A Journal of Theoretical and Practical Chemistry and Physics,

IN THEIR APPLICATION TO

ENGINEERING AND MANUFACTURES.

EDITED BY

JAMES H. GARDINER, F.Inst.P., F.C.S.

and

J. G. F. DRUCE, M.Sc. (Lond.), R.Nat.Dr. (Prague).

VOLUME CXXVII. 1923.

LONDON.

PUBLISHED AT THE OFFICE, 97, SHOE LANE, E.C. 4.

AND SOLD BY ALL BOOKSELLERS.

1923.

LONDON:
PRINTED BY REA, WALKER & INCHBOULD, LTD.,
224, BLACKFRIARS ROAD, S.E.1

Em 56.M60
DZ.127

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No. 3299.—JULY 6, 1923.

THE CHEMICAL NEWS,

VOL. CXXVII. No. 3299.

GLASS MAKING IN ENGLAND.

The great war and the industrial struggle that is following it has profoundly influenced many British industries, but upon none has the effect been so pronounced as upon that of glassmaking.

Glass is so familiar to all of us that we often fail to realise the magnitude of the industry. There is probably not a man, woman, or child but handles glass in some form or another many times in each day of their life, and when one considers the fragility of the ware, it is apparent that the labour involved in its preparation and fabrication must be enormous.

Apart from the domestic use of glassware there is scarcely an industry in existence that does not need glass in some form or other, and for the progress of chemistry and physics the production of good glassware is a matter of vital importance.

The war brought home to all of us the need for what has been called scientific glassware, as without it research in any direction is practically impossible. The immediate result was the formation of the Glass Research Association, the Society of Glass Technology, and other bodies. Many manufacturers extended their works, new factories have come into existence, and there is every indication that great progress has already been made in the industry. Great strides have been made in America in mechanical appliances for the production of glassware, and machines have been erected in England for the rapid manufacture of bottles, jars, and other domestic necessities, and containers in glass are now being produced in England daily by the million.

Glassmaking as a fine art has been practised in England for a great many years, and the recent publication of a beautifully illustrated work on the art of glassmaking, by the late Harry J. Powell,* who, until lately, managed the old Whitefriars Glass Works in the City, brings the beauty of the craft into full prominence. Mr. Powell was probably the most successful producer of truly art glassware in England, and he devoted his whole life to the work, his book will for many years rank as one of the art treasures of the country. Mr. Powell was very much concerned lest the art of glass-craft should die out in England, and there undoubtedly are indications that the labour conditions of recent years are such that the production of successful craftsmen is not promising, but for all that there are those who do not regard the problem as hopeless, and we understand that in the new Whitefriars glassworks that have been erected at Wealdstone, Middlesex, serious efforts are already being made for the systematic training of glassworkers to take the place of the old-world craftsmen who produced the exquisite examples illustrated in the work in question. The members of the Society of Glass Technology, in company with Professor Turner, of Sheffield University, recently visited the newly launched glassworks, and the party were shown the modern furnaces, annealing ovens, kilns and elaborate work-

shops erected by the company, and there appears to be genuine hope that the disaster feared by Mr. Harry Powell will be averted by meeting modern labour conditions by modern methods of treatment. The educational advantages possessed by the youth of the present day should largely compensate for the fact that he is not allowed to take up work that involves the night duties of a glassblower until he has passed the age of sixteen, whereas some of the craftsmen mentioned in Mr. Harry Powell's book commenced work when eight or nine years of age. The fact that many of these men, although now with records of more than 40 years' service, are still hale and hearty, shows that the work is not unhealthy.

Those who read Mr. Harry Powell's book will not fail to be impressed with the beauty of the manufacture, and will endorse our opinion that every effort should be made to ensure the continuance of one of the most charming of British industries.

J.H.G.

* *"Glass-making in England," by H. J. Powell, C.B.E., Cambridge, at the University Press*, 1923.

STUDIES ON CATALYTIC ACTION.

II.—CATALYTIC PREPARATION OF PARA-CYMENE AND ITS FORMATION IN SULPHITE TERPENTINE.

By Shigeru Komatsu, Hisashi Nakamura, and Masao Kurata.

Klason[1] first noticed that the etherial oil collected during the manufacture of pulp from spruce by the sulphite process, consists mainly of para-cymene and not of terpenes. Sulphite terpentine from the pulp mills of U.S.A. was studied by Herty and Graham,[2] A. W. Schorger[3] and M. Philips[4] with a view to the utilisation of para-cymene in it. O. Aschan[5] and J. Alfthan[6] have, also, studied the terpentine in Finland.

The sulphite terpentine, we studied, wa[s] obtained from the pulp mill at Ochiai, Karafuto, where sulphite pulp was manufactured from Yezo-matsu and Todo-matsu. The crude oil which amounted to 140 grm. was dark brown in colour, $d_4^{15} = 0.965$. It was subjected to steam distillation and a light-yellow oil was obtained, which, after drying with anhydrous sodium sulphate was distilled:

First fraction, B.p., 174–270° 70 grm.
Second fraction, B.p., above 270° 35 grm.

Two fractions were fractionated on metallic sodium, and the fraction boiling at 173–175° was collected. The yield was 50 per cent. of the crude oil.

The physical constants and the elementary composition of the purified substance were determined with the following results.

It gave C=89.33; H=10.34; ($C_{10}H_{14}$ requires C=89.48; H=10.52), d_4^{25} = 0.85381; n_D^{25} = 1.4821; M.R.=44.80.

For identification with para-cymene, it was oxidised with potassium permanganate into tere-phthalic acid[7] and para-hydroxy-isopropyl benzoic acid[8] and the latter melt at 156° and gave on analysis C=66.23; H=6.64; ($C_{10}H_{12}O_3$ requires C=66.64; H=6.72).

On the other hand, the substance was sulphonated with conc. sulphuric acid following Claus' directions,[9] and sodium salts of mono- and di-sulphonic acids were separated by aid of their solubility in alcohol solution, and di-sulphonic acid salt was analysed; Ba = 31.32($C_{10}H_{12}O_6S_2Ba$ require Ba=31.95).

Terpenes of the formula $C_{10}H_{16}$ by dehydrogenation, were ultimately converted into para-cymene; consequently the transformation was sometimes made use of in the determination of the constitution of the compounds.[10]

Kekule[11] has studied the conversion of terpene into cymene by oxydation with phosphorous sulphide. L. Ruzika, J. Meyer and M. Mingazzini[12] have obtained para-cymene from limonene and terpinene by catalytic oxydation with sulphur, fol-

[1] *Ber. D. Chem. Ges.*, 1900, XXXIII., 2343.
[2] *J. Ind. and Eng. Chem.*, 1914, VI., 803.
[3] *Ibid.*, 1918, X., 258.
[4] *J. Amer. Chem. Soc.*, 1922, XLIV., 1775.
[5] *Zellstoff Chem. Abhand.*, 1920, 1.73.
[6] *Ber. D. Chem. Ges.*, 1920, LIII., 78.
[7] *R. Fittig, A. Korbrich and T. Jilke: Lieb. Ann.*, 1868, CXLV., 144.
[8] *O. Wallach: Ibid.*, 1891, CCVXIV., 10.
[9] *Ber. D. Chem. Ges.*, 1881, XIV., 2140.
[10] *V. Meyer and P. Jacobson: Lehrbuch d. Org. Chem.*, 1902, II., 110.
[11] *Ber. D. Chem. Ges.*, 1869, II., 121.
[12] *Hel. Chim. Acta.*, 1922, V., 356.

lowing Vesterberg's directions,[13] and the same process was applied by W. *Friedmann*[14] to naphthene hydrocarbons.

The authors have succeeded in the catalytic preparation of para-cymene, the main constituent of sulphite terpentine, from pinene and menthene respectively.

136 grm. pinene obtained from commercial terpentine oil, were heated with 70 grm. sulphur in a flask at 200° for 23 hours, the reaction product was distilled under reduced pressure and 71.5 grm. of the product was obtained. It was distilled under ordinary pressure after treating with 10 per cent. caustic soda solution, dried with calcium chloride, and a fraction boiling at 170-275° was collected. The yield was 55 grm. (52 per cent. of the theoretical).

The product, thus obtained, on distilling with metallic sodium, was all distilled out between 165-175°. It was purified by repeated distillation with metallic sodium.

The purified substance d^{25}_{4} =0.8542; n^{25}_{D} =1.4743; M.R.=44.41, was analysed: it gave C=88.37; H=11.34; ($C_{10}H_{14}$ requires C=89.45; H=10.55).

It was oxydised with potassium permanganate into para-hydroxyisopropyl benzoic acid[15] which melted at 156-156.5° and gave C=66.44; H=6.33; ($C_6H_4C(OH)(CH_3)_2$-COOH requires C=66.64; H=6.72).

In the same manner, menthene prepared from menthol by catalytic dehydration with thoria was transformed into para-cymene.

140 grm. menthol were passed on thoria heated at about 400°, and yield 125 grm. light greenish yellow liquid substance, d =0.817, which distilled between 155-210°. It was purified by repeated distillation with metallic sodium, and the following fractions were obtained:

The fraction boils at 145-164° under 752 mm., with 10 per cent. of the yield.

Other fraction boils at 164-167° under 752 mm., with 40 per cent. of the yield.

The second fraction was confirmed by analysis to consist of menthene,[16] d^{25}_{4} = 0.8096; n^{25}_{D} = 1.4469; M.R. = 45.60; which gave C=86.10; H=12.02; ($C_{10}H_{18}$ requires C=86.87; H=13.13).

Menthene, thus obtained, was heated with sulphur at 200° for 24 hours, and the reaction product was subjected to distillation on metallic sodium to purify. The cymene fraction boiling at 170-173.5°, d^{25}_{4} = 0.8389; n^{25}_{D} =1.4740; M.R.=44.94; gave on analysis C=87.68; H=10.92. ($C_{10}H_{14}$ requires C=89.45; H=10.55).

The conversion of menthol and borneol by simply heating with sulphur at about 200° into cymene, was tried, but with no result.

Terpenes of the formula $C_{10}H_{16}$, on the contrary, can easily be transformed into cymene by catalytic oxydation with sulphur.

Aromatic hydrocarbons and their oxygen derivatives, such as para-cymene and safrol are widely distributed, being generally associated with the essential oils in plants. The origin and the mechanism of the formation of the aromatic compounds in the flora were interesting problems.

As to the formation of para-cymene in sulphite terpentine, Klason[17] has already put forward the following opinion:

"Alles Terpentinöl soll ja auch nach den vorhandenen Angaben etwas Cymol enthalten, und im Holze sind die aetherische Oele lange Zeit dem Einfluss der Luft ausgesetzt worden. Wie man nun diesen Uebergang im Lichte der Engler'schen Theorie der Autoxydation erklären soll, mögen künftige Untersuchungen darthun. Entweder wurden von der zunächst entstandenen superoxydartigen Verbindung zwei Wasserstoffatome direct wegoxydirt oder es entsteht intermediär ein Alcohol, welcher durch Wasserabspaltung in Cymol übergeführt wird." Much more probably the formation of cymene in wood may be attributed to the autoxydation of etherial oils, as Klason stated. Whether the sulphite terpentine was formed in a digester during the manufacture of pulp, by the same mechanism is very doubtful.

Our hypothesis, however, for the formation of the sulphite terpentine, is quite different from Klason's, and is grounded on the experiments described above; the terpene existing in the wood would probably be transformed during the manufacture of pulp by the sulphite process, into para-cymene by catalytic oxydation with sulphur which is liberated in a free state in the digester.

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13 *Ber. D. Chem. Ges.*, 1903, XXXVI., 4200.

14 *J. Chem. Soc.*, 1917, CXII., 13.

15 *O. Wallach*: *Loc. cit.*

16 *P. Walter*: *C.R.*, 1838, VI., 473; *Lieb. Ann.*, 1839, XXXII., 288.

17 *Loc. cit.*

The evidences in favour of our view of the formation of sulphite terpentine, are easy to quote here from literature.

Shinozaki[18] has isolated from the essential oils obtained by steam distillation of Yezo-matsu and Todo-matsu pinene and phellandrene, which were proved by our experiments to transform into para-cymene.

We cannot pass over without mentioning here the most important fact that free sulphur actually exists in the acid-liquor used for pulp manufacture, cited in Klason's article.[19]

—(*From the Memoirs of the College of Science, Kyoto Imperial University*, Vol. IV., Mar., 1923.)

THE REPORT OF THE CHEMICAL EXAMINER'S DEPARTMENT (PUBLIC HEALTH), GOVERNMENT OF MADRAS.

Read—the following papers:—

Letter from Major Clive Newcomb, M.D., A.I.C., I.M.S., Chemical Examiner to Government, to the Secretary to Government, Local Self-Government Department (through the Surgeon-General with the Government of Madras, Madras), dated Madras, the 26th March, 1923, No. 538.

The following is abstracted from the Report for 1922:—

MEDICO LEGAL INVESTIGATIONS.

In the 220 cases of suspected human poisoning investigated, poison was detected in 108, giving a percentage of detections of 49.1 as compared with 40.6 in the previous year.

It is a matter for regret, as previous Chemical Examiners here have remarked, that more time is not available for trying new toxicological methods. In all branches of practical chemistry, but especially in toxicology, new tests or methods of analysis, even if most carefully described, cannot be put into practice without many controls and personal investigations by the analyst. A little, however, has been done.

In the extraction of morphine from viscera, a method which had been used here before was again tried on some cases, in view of its recommendation in Lucas' *Forensic Chemistry*. Of the evaporated acid alcoholic extract of the viscera, a small portion was extracted with ether in the presence of sodium bicarbonate for the porphyroxin test. To the remainder sodium hydroxide was added, and it was then extracted first with ether, next with chloroform to remove other alkaloids, and thirdly with a mixture of ethyl acetate and ether to extract the morphine. In a case in which both dhatura and opium were suspected and in which this procedure was used, the presence of a mydriatic alkaloid was proved in the chloroform extract and the presence of morphine in the ethyl acetate-ether extract, in addition to positive porphyroxin and meconic acid tests. In another case an infant aged two years was suspected to have died from an overdose of opium, but in this case the porphyroxin test was the only one which was positive. The porphyroxin test is said to be a very delicate and reliable one for Indian opium.

Beam's test for Cannabis Indica, both in its original and modified form (*vide* Lucas' *Forensic Chemistry*) was tried on a sample of charas from the Punjab and found to work well.

Some experiments were made by Dr. S. Rajagopal Nayudu, to try to find tests for madar. An alcoholic extract of any part of the plant except the juice after evaporation to dryness and taking up in water gave crystals with a saturated solution of iodine in 10 per cent. potassium iodide, which bore some resemblance to Florence's crystals, and crystals with saturated aqueous picric acid of probably a characteristic shape. The alcoholic extract of the juice on evaporation left an orange yellow, bitter, poisonous resin, which gave a bluish colour with strong hydrochloric acid and green colour with strong sulphuric acid. White dilute acids, it gave a fine pink colouration. Beam's test was negative with madar juice. In two cases of suspected madar poisoning we were able to extract a bitterish resin from viscera which proved fatal to a frog and gave the above reactions. The cases, therefore, presumably were of madar poisoning, but this could not be considered to be conclusively proved.

The test for arsenic described in the *J.C.S.Abs.*, 1922, page 584, was tried, and found to work well with a solution of arsenious acid. The quinine molybdate test

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[18] *Kogyo-Kwagaku Zasshi*, 1912, XV.,).

[19] *Uregelmassige Gang v. Sulphitstoffabkung u. desen Ursache*, 1910, p. 63.

described in the *Analyst*, 1922, page 317, was tried and found to work satisfactorily.

Some experiments were made on the adsorption of brucine sulphate from dilute aqueous solution by kieselguhr with a view to the possibility of using adsorption for the extraction of alkaloids from viscera.

In these experiments the brucine was estimated by evaporating to dryness and weighing the residue of a measured quantity of the solution before and after adsorption, making a small allowance for the amount of soluble substances dissolved from the kieselguhr.

The estimation of brucine in dilute solution by precipitation with Dragendorff's reagent (Bismuth potassium iodide) was also tried. The amount of precipitate was estimated by means of a simple form of nephelometer. This was simply a glass rod graduated into millimetres along its stem with a short platinum wire bent at right angles to the rod at one end. It was pushed into the suspension of the precipitate holding the stem vertical till the platinum wire could no longer be seen and the length of rod immersed noted. The method was quick but only accurate to within about 10 per cent.

GENERAL ANALYSES.

The number of these analyses done during the year was 570, against 564 in 1921.

The Customs department sent 144, of which 50 were analyses of gold or silver thread or lametta. These frequently gave small traces of gold or silver, probably indicating they were plated with the real metals.

The General Hospital, Madras, sent 122 articles for analyses, of which 106 were stomach washes after test meals. Our routine in examining these is to estimate free hydrochloric acid by Buntzberg's method, total acidity by titration wih $N/_{10}$ soda, using phenolphhaleïn as indicator, and to test qualitatively for lactic acid by Uffelmann's method. A direct estimation of the hydrogen ion concentration would probably be of more value, and with this end in view solutions of standard P_h are being prepared. Whenever possible, these are prepared by two methods and the colours given by various indicators compared. A great deal of care is needed in the preparation of the standard solutions and in purifying the chemicals used to get perfect matches.

The danger of relying on the labels of bottles for more than an approximate indication of their contents was well illustrated by the case of a bottle labelled "Pure saccharose," which was being used in the Hygiene Laboratory as a standard in work with a polarimeter. It was sent to us because of the discordant results which were obtained, and on analysis was found to contain a very considerable amount of glucose.

The accurate determination of the density is often a most useful test of purity of a liquid or a check on the determined strength of a solution. To take a specific gravity with a bottle takes a considerable time even at the temperature of the laboratory, and at any other temperature requires a carefully regulated thermostat. Most densities are given at (15° C.), and in Madras to keep a thermostat at a temperature lower than about 30° C. would require prohibitive quantities of ice. An investigation was therefore made into the accuracy obtainable with an ordinary Westphall's balance and some previous calibrations of one of our balances carefully revised. The reading of the balance can be made very quickly and with a liquid which is changing in temperature fairly rapidly a series of readings can be taken, the mean of which should be reliable to within + 0.0003. Some experiments have been made during the year, as time could be found for them, to see if a more useful test for the purity of chloroform could not be devised using this instrument, than the present B.P. test of taking the specific gravity at 15° C. B.P. chloroform contains a small quantity of alcohol as a preservative. It was considered that if this alcohol were removed and the density determined before and after removal this might afford a measure of both the amount of added alcohol and the purity of the residual chloroform. The alcohol can be easily extracted from chloroform by washing it with water. Five washings with a bulk of water equal to that of the chloroform each time are sufficient. The density of the chloroform may be determined wet and a small allowance made for the wetness. Experiments to determine the changes in density produced by water, alcohol and temperature are still going on.

We were consulted about a "disease" developed by some mercury used in a lighthouse to float the revolving part of the lamp so as to make it turn easily. A sample of the diseased mercury showed that it had become partly converted into a grey viscid, slimy substance. On examination it turned out to be an emulsion of mercury and oil,

of such a consistency as to effectually clog almost any mechanism.

On another occasion we were asked to match a special lubricating oil for an electric machine used at the Ophthalmic Hospital, Madras. We obtained two lubricating oils, one slightly more viscid and one rather less viscid than the sample, and by testing the viscosity of mixtures of the two found the proportion in which they had to be mixed to match the sample as regards viscosity. The difficulty in this case was that only about 2 cc.'s of the sample were available, so that the ordinary types of viscosimeter (except Ostwald's which we did not then possess) were inapplicable. The viscosities were measured by noting the time taken for 0.5 cc. of the oil to run out of a 1 cc. pipette graduated into 1/100ths. We could not match both the viscosity and the density, so we recommended a mixture which made the viscosity right, and I understand that machine has been running well on our mixture since.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, JUNE 28.

Papers read:—

V. H. BLACKMAN, F.R.S., A. T. LEGG, and F. A. GREGORY. *The Effect of a Direct Electric Current of very Low Intensity on the Rate of Growth of the Coleoptile of Barley.*

The coleoptile (sheathed plumule or young stem) of barley seedlings are exposed to an electric discharge from a point charged *positively* to about 10,000 volts (rest value) and placed at such a height above the coleoptile that a current of 0.5×10^{-10} amp. passes through it, the current density being 4×10^{-9} amp. per cm.^{2} Under these conditions the rate of growth is markedly accelerated from the first hour onward, showing in the third hour a percentage increase above that of the control plants of 7.53 + 1.95.

After the cessation of the current a well-marked "*after-effect*," greater than the direct effect, is to be observed, the enhanced rate of growth steadily continuing and showing a percentage increase of 15.68 + 2.62 above that of the controls. The after-effect is greater with a short period of discharge of one hour than with a longer period of three hours.

When the point is *negatively* charged the rate of growth is increased during the first hour, but the increase, instead of becoming greater with time, as with a current in the other direction, becomes less. An after-effect follows here also, but it is markedly less than that resulting from a positive discharge.

Experimental evidence is advanced for the view that the gaseous products of the discharge and the "electric wind" play little or no part in the stimulation of growth observed. The current alone appears to be of importance, a view which is supported by the fact that its direction exerts such a marked influence on the degree of stimulation.

M. S. PEMBREY, F.R.S., N. W. MACKEITH, W. R. SPURRELL, E. C. WARNER, and H. J. WESTLAKE. *Observations on the Adjustment of the Human Body to Muscular Work.*

Papers read in title only:—

MISS R. M. TUPPER-CAREY and J. H. PRIESTLEY. *The Composition of the Cell Wall at the Apical Meristem of Stem and Root.* Communicated by Dr. F. F. Blackman, F.R.S.

The walls of the apical meristem of stem and root differ in the ease with which cellulose may be detected in them with iodine reagents. As the result of macro-chemical and micro-chemical experiment it is concluded that the cellulose in the wall of the root meristem is masked by its combination with other substances, particularly proteins and fatty acids. In the shoot meristem the cellulose is closely linked with larger quantities of pectin but less protein and fatty acid are present, especially when the shoot is growing in the light. These conclusions seem to throw further light upon the comparative difficulty with which diffusion appears to take place through the apical meristem of the root compared with that of the shoot.

L. J. HARRIS. *The Titration of Amino- and Carboxyl-Groups in Amino-Acids, Polypeptides, etc.* Communicated by Prof. F. G. Hopkins, F.R.S.

F. A. E. CREW. *Studies in Intersexuality.—II. Sex-reversal in the Fowl.* Communicated by Prof. R. C. Punnett, F.R.S.

W. FINKLER. *Analytical Studies on the Factors causing the Sexual Display in the Mountain Newt (Triton alpestris).* Communicated by Prof. E. W. MacBride, F.R.S.

G. A. SCHOTT, F.R.S. *On the Scattering of X- and γ-Rays by Rings of Electrons.—The Effect of Damping of the Incident Radiation.*

The object of the investigation is to examine the effect of the damping of incident X- and γ-rays on their scattering by revolving rings of electron, with the view of determining whether the diminution of the total scattering observed by Ishino for aluminium, iron and lead can be attributed wholly or partly to this cause. Damping of the usual type, of an amount compatible with the production of moderately sharp lines in the X-ray spectrum, is found to increase slightly the total scattering of short waves, such as the hard γ-rays used by Ishino, although it decreases slightly that of long waves. A single electron ring, however, such as we postulate in hydrogen and ionised helium on Bohr's theory, is completely unaffected by this type of damping. It is hardly possible that damping can diminish the total scattering for any type of atom below the amount required by the Simple Pulse Theory, certainly not to the extent required by the experiments of Ishino and the more recent ones of A. H. Compton.

P. A. MACMAHON, F.R.S. *On a Class of Transcendents of which the Bessel Functions are a Particular Case.*

L. C. MARTIN. *The Photometric Matching Field.* Communicated by Prof. H. L. Callendar, F.R.S.

During a previous investigation it was noticed that an improvement in the visibility of faint contrasts observed with central vision could be obtained by stimulating the peripheral regions of the retina. Some explanations of this and allied effects are discussed. As a practical application experiments are described which show that an increase in precision of the order of 30 per cent. can be obtained in photometric matches by surrounding the photometric field with a larger area of approximately equal brightness.

G. P. THOMSON. *Test of a Theory of Radiation.* Communicated by Sir Joseph Thomson, F.R.S.

Experiments are described with positive rays which show that visual and photographic effects can be obtained with trains of waves shorter than those produced in the emission of a quantum of light.

A. LL. HUGHES and P. LOWE. *Intensities in the Helium Spectrum.* Communicated by Prof. H. A. Wilson, F.R.S.

The distribution in intensities in the helium spectrum, when excited by impacts between electrons and atoms, has been studied as a function of the energy of impact of the electrons, all other variables being held constant. The energy of impact varied from 34 volts to 210 volts.

The outstanding result of the work is that the curve showing the intensity of any spectrum line as a function of the energy of impact is characteristic of the series to which it belongs. The intensities in the Doublet System all decrease rapidly as the energy of impact is increased from 34 volts. The rate of decrease is greatest for $1\pi - m\sigma$ and least for $1\pi - m\delta$. The Principal Series, $1S - mP$, of the Singlet System is characterised by a very great increase in intensity as the energy of impact is increased from 34 volts up to about 80 volts, beyond which there is little change. The lines of the Diffuse Series, $1P - mD$, all show a maximum at about 75 volts, the rise to maximum being progressively greater the higher the term number of the line. The lines of the Sharp Series, $1P - mS$, after a small initial rise to 60 volts decrease slightly.

A. A. DEE. *The Effect of Quenching from above the Carbide Transition Temperature upon the Magnetism of Steel.* Communicated by Prof. S. W. J. Smith, F.R.S.

The first accurate determination of a transition point in iron carbide at which the ferromagnetism disappears during heating, in a similar way to that of iron at the critical temperature of the latter, was made by S. W. J. Smith in 1912. It has recently been suggested by Thompson and Whitehead that this carbide transition, described as from α to β cementite, is such that the carbide can be retained in the β condition by quenching from above the transition

temperature. The experiments described in the present paper show that the magnetism of steel at ordinary temperatures is not materially altered by quenching of the kind above described and, therefore, that the return of the carbide to the ferromagnetic state is not retarded by sudden cooling from above the transition temperature.

T. S. P. STRANGEWAYS and H. E. H. OAKLEY. *The Immediate Changes observed in Tissue Cells after Exposure to Soft X-Rays while growing "in vitro."* Communicated by W. B. Hardy, Sec. R.S.

Tissue cultures *in vitro* were exposed to soft X-rays for gradually increasing periods, varying from 5 minutes to 2 hours.

Four cultures were exposed at a time: two of these were stained immediately, and two after being returned to the incubator for 80 minutes. It was found:—

(1) That there was a latent period of about 15 to 20 minutes before the changes produced in the cells by irradiation can be recognised.

(2) That after 5 minutes irradiation development of new dividing cells was lessened. After exposure of 20 minutes or longer the formation of new dividing cells practically ceased.

(3) After exposure of 5 minutes granular changes and fragmentation of the chromosomes were observed in some cells in mitosis at metaphase and anaphase. After 15 minutes' irradiation the majority of cells in mitosis showed these changes, and also a definite lag in the passage of some chromosomes to the poles of the spindle, and often a definite lag in cell-division itself, but in spite of these changes in the chromosomes many, if not the majority, of the cells passed through the various phases of mitosis and completed division. After the longer exposures, however, some of the resulting daughter-cells showed abnormality.

(4) After exposure of 25 minutes or longer some cells in mitosis showed clumping of the chromosomes at metaphase.

(5) As time of exposure increased there was increase in size and alteration in structure of cytoplasm, nucleus and nucleolus of some fully formed cells.

(6) After an exposure of 60 minutes or longer, definite changes occurred in cytoplasm, nucleus and nucleolus of some cells. These affected cells became disorganised and showed irregular and varying outline. Eventually cytoplasm and nucleus broke up, disintegrated and appeared to go into solution in the surrounding medium.

ROYAL INSTITUTION OF GREAT BRITAIN.

A general meeting of the members was held on Monday, July 2, 1923.

NATIONAL ENGINEERS' ASSOCIATION.

ADDRESS BY W. H. CASMEY, C.E., AT WAKEFIELD, JUNE 25.

Had I the qualifications of an artist instead of being a critic of smoky chimneys, I should paint three historical pictures which would have no equal in the National Gallery, and the subjects would be:—

First picture, entitled *The Birth of Power 687*, and would indicate a tall, monkish figure, with a basket of blackberries on one arm and a lump of coal under the other.

The second picture would show a finely built, solid-looking Yorkshireman, gazing at a smoky chimney, and the title would be *Green's Common Sense, 1845.*

My third artistic effort would show a big pile of coals, on which would appear in white letters, "Thirteen hundred million tons," and above would be a dense mass of black clouds, and this should have the title of *Coals, Clouds, and Wastage, 1923.*

The first picture would represent the Monk of Glastonbury Monastery, who, whilst gathering blackberries in an old quarry in the year 687, came across an outcrop of coal, and, not having seen what he terms "black stone" before, took a piece for the inspection of the prior, and he, after examination, considered it of no consequence, and told his man to throw it on to the fire. Wood was the only fuel then used.

The black stone, helped by the wood fire, soon made the principal of the Monastery interested, and from this time, coal was the only fuel used there, and the secret of its heating power was kept for over 100 years, and was then shared with a monastery in Northumberland, and it is probably due to this that Newcastle coals were so much in demand in the South two or three centuries later.

If we now make a leap forward of 1,000 years, we are in the company of James

Watt and others in Cornwall, and see their efforts in constructing a steam generator, which finally developed into the Cornish boiler.

Another stride of 50 years, and we reach 1800, in which year the first steam mill in Bradford was started, the engine of which developed 15 horse power.

Mr. Ed. Green, of Wakefield, recognising the huge wastage of coal from steam boilers, conceived the idea of building up a business by utilising the waste heat for heating the water before passing it into the boiler, and this invention, the Green's Economiser, is now a household word wherever steam boilers are in use, and for many years may be considered as having saved steam users eight to ten million tons of coal per year.

Mr. Brownlie, in his tests of 1,000 boilers, found the average overall efficiency was 60 per cent., the maximum being over 80 per cent., the minimum under 50 per cent. Now, is there any reason in allowing such conditions? Twenty-two boilers out of 1,000 boilers giving over 80 per cent., and others 30 per cent. lower; in other words, 14s. worth of coal in one case doing the work of 20s. in another.

Let us look at the subject more closely, and we find the average CO_2 readings were 7 per cent.; this indicates 33 lbs. of air per lb. of coal, and if the calorific value of the coal averaged 12,500 B.Th.U.s, the average furnace temperature would be 1,506 degrees.

By decreasing the air supply to 18 lbs. of coal, the CO_2 readings will be 13 per cent. and the furnace temperature 2,797 degrees, a difference of 1,291 degrees by reducing the air supply per lb. of coal from 33 lbs. to 18 lbs. A difference of 1 per cent. CO_2 shows an average difference in furnace temperature of 215 degrees. The actual figures per 1 per cent. CO_2 are as follows:—

With 7 p.c. CO_2	Gases per lb. of coal	33.8 lbs.	Furnace temperature	1,506 degrees.
,, 8 p.c. ,,	,, ,, ,, ,, ,,	29.8 ,,	,, ,,	1,748 ,,
,, 9 p.c. ,,	,, ,, ,, ,, ,,	25.5 ,,	,, ,,	1,962 ,,
,, 10 p.c. ,,	,, ,, ,, ,, ,,	24.0 ,,	,, ,,	2,170 ,,
,, 11 p.c. ,,	,, ,, ,, ,, ,,	21.8 ,,	,, ,,	2,390 ,,
,, 12 p.c. ,,	,, ,, ,, ,, ,,	20.2 ,,	,, ,,	2,532 ,,
,, 13 p.c. ,,	,, ,, ,, ,, ,,	18.6 ,,	,, ,,	2,797 ,,

If a fire is at its best and part of the load is taken off, the present-day practice is to lower the damper and so minimise the rate of combustion, but the effect is serious from an economical point of view, as the heat of the fire rushes into the boiler due to the lower temperature of the latter, and thus reduces quickly the temperature of the fires, so that when the load is put on again comparatively cold fires are found, and these, when stoked, being below the gas ignition point, give off black smoke. Three minutes' smoke wastes 1 per cent. of the coal used per hour.

During my series of lectures in Wakefield, I suggested to the audience one night that a present-day need in the direction of economy was a movable bridge for the furnaces, to enable the quality of combustion to be maintained, so that the length of the fires could be kept suitable to the steam demands, and one of the class tackled the subject, and a model of his now patented device is here for your inspection.

In another invention of recent date for tank boilers, the details of construction I am not yet conversant with, but the fact of heating the air before it enters the furnace must of necessity be an economy, and one of the best aids in preventing the formation of smoke.

For many years I have studied the problem, why a tank boiler was so inefficient, as in some cases we have seen the boiler is practically dependent on the economiser. Especially does this happen when the air supply is much too high and more so when the coals used have a big proportion of hydrocarbons (gas).

In an attempt to assist in the direction indicated, a patent has recently been taken out for fitting up a furnace in such a way that a big proportion of the convected heat is transformed to radiant heat, and by this arrangement I think the actual boiler efficiency can be increased 8 per cent. or ten per cent.

It may interest many here to know that 27 years ago, Mr. Michael Longridge carried out some tests with a 30′ 0″ x 8′ 6″ Lancashire boiler, and by reducing the grate area from 42 to 35 sq. ft. when burn-

ing 35 lbs. of coal per sq. ft. of grate, the overall efficiency of boiler and economiser was 76 per cent.

The subject of smoke prevention and its natural resultant coal economy has never been so seriously considered as at present, and it is due- more to the medical faculty than to the engineer that the stand is now being made.

We engineers and manufacturers burn coal, and in doing so not only waste a large portion of it, thereby robbing ourselves and depriving our descendants of their just rights, but we create conditions responsible for our annual fogs, with their long train of losses and inconveniences, depriving our industrial towns of nearly two hours' sunshine per day, and contributing in no small measure to our high death rate from respiratory troubles. Our annual coal wastage is little short of 50 million tons.

A deputation of medical men and others visited the Ministry of Health a few days ago, and one of the facts laid before the Minister was that six days' fog in Leeds increased the infantile death rate from 50 per 1,000 to 175, and in the case of a four days' London fog in November last, the death rate in the City increased from 12.6 to 14.3 per thousand.

Smoke cannot be formed with properly proportioned furnaces, flues and chimneys, as given these and ordinary care in stoking, the furnace temperature is high enough to at once ignite the gases as liberated, and heat instead of smoke is produced.

Boilers should all be fitted with draught gauges, CO_2 indicators and water meters. Without them, stoking and boiler efficiency is mere guess work, and only leads to confusion. The water in a boiler should not be any higher than the working level. Remember 1″ above working level in a 30′ 0″ x 9′ 0″ boiler requires ½ cwt. of coal extra *per hour.*

My final word is, we spend many millions sterling per year in providing pure water to the community, and it is quite right that this should be done, but yet, the senses of sight, smell or taste will prevent us from drinking impure water, but in comparison, we waste fully 50 million tons of coal per year in fouling the atmosphere we are compelled to breathe, and directly cause over 1,000 deaths every week with our floating and easily prevented aereal sewage!

THE FARADAY SOCIETY.

MONDAY, JULY 2.

Determination of the Density of Charcoal by Displacement of Liquids, by J. B. FIRTH, D.Sc., F.I.C.

In two previous papers Driver and Firth show that the sorption of liquids by various types of charcoal is only complete after many days. Further it is shown that the volume of liquid sorbed varies with the different charcoals; and also for any given charcoal varies with the different liquids.

It would appear from these results that the values obtained for the density of a given specimen of charcoal by a determination of the displacement in a given liquid would vary continuously until the sorption was complete. Again since the volume of liquid sorbed varies with the different liquids the final density values obtained would likewise vary.

In the experiments described the apparent densities of cocoanut shell charcoal and sugar charcoal have been determined after definite intervals, for several liquids.

From the results obtained the value for the density of the charcoal increases with the time of contact between the liquid and the charcoal. Further the final density value varies with the different liquids.

From the previous study of the sorption of liquids by charcoal it would appear that the rate of change in the density value, and also the final density, will be determined by the rate of sorption and sorptive capacity respectively.

Capillarity is an important factor; without doubt, the capillarity alone will not suffice to explain the present results. It is the opinion of the author that an additional force of a chemical nature, which is responsible for sorption phenomena, also operates, and is fundamental. This force varies in the different charcoals also between the *same* charcoal and different liquids.

In the case of benzene and water with cocoanut shell charcoal, since the density in benzene is higher than that in water in spite of the fact that the capillary forces are less in the case of benzene, it follows that the sorption attraction between the charcoal and benzene is considerably greater than that in the case of charcoal and water, and the difference between the capillary forces is more than counterbalanced. Hence it is concluded that the difference in the observed densities of charcoal in the various liquids is largely determined by the

and the liquid, and to a much lesser degree by the capillary forces exerted in the system.

A further factor which must also influence the final result is the compressibility of the liquids. The liquids in the finer capillaries are highly compressed, and the compression will vary with the different liquids.

Concentration Cells in Methyl Alcohol, by J. GRANT and J. R. PARTINGTON.

The present investigation was undertaken with the object of clearing up the apparent deviation from Nernst's formula. The results show that no abnormalities, such as Wilson (1906) found, exist in the case of silver nitrate in methyl alcohol, the experimental values being in quite satisfactory agreement with Nernst's formula.

The theoretical results were calculated on the formula

$$E = \frac{2v}{u+v} \cdot \frac{R.T.}{N.F.} \log_e \frac{\mu_1 . c_1}{\mu_2 . c_2} = \frac{2v}{u+v} \times 0.0002 \; . \; T \; . \; \log_{10} \frac{\mu_1 . c_1}{\mu_2 . c_2}.$$

The values of u and v were taken from a paper by Jones and Rouiller. This gives the transport number of the anion of silver nitrate in methyl alcohol as 0.561 at 0° C. and 0.572 at 25° C.

The values of μ_1 and μ_2 at 0° and 25° C. were taken from Jones and Bassett (*Amer. Chem. J.*, 1904, XXXII., 409-445), and were given earlier in the present paper.

Finally the observed values of the E.M.F.'s were corrected for temperature, and their values found at 0° and 25° C. so as to bring them into line of comparison with the calculated results. The E.M.F.'s were taken as directly proportional to the absolute temperatures.

The Law of Definite Proportions in the Light of Modern Research, by ULICK R. EVANS.

More than a century ago, a controversy took place between Proust, who maintained that homogenous bodies had a fixed composition, and Berthollet, who believed that the composition was variable. Since the law of definite proportions occupies an honourable place in all our chemical text-books, it may be considered that the view of Proust has prevailed, at least in the case of crystalline bodies; it is generally admitted that glassy bodies have no fixed composition. Of course, even among crystalline substances the existence of bodies ("mixed crystals" or "solid solutions") having variable composition is recognised; for instance, in sodium chloride, part of the sodium atoms can be replaced by potassium, and part of the chlorine by bromine; but the mixed crystal (Na, K) (Cl, Br) thus obtained still appears to obey the rule that the number of metallic atoms present shall be equal to the number of halogen atoms.

When we consider the case of materials built up of very small (ultra-microscopic) particles, in which the "surface layers" cannot be neglected, our ideas receive some modification; Quarteroli has calculated that ultramicroscopic crystals of iron pyrites may deviate appreciably from the proper composition FeS_2. Gelatinous precipitates, such as aluminium hydroxide, will usually contain more water than corresponds to the formulæ commonly applied to them, since they contain, besides "combined" water, a great deal of "capillary" and "free" water; recently Foote and Saxton have endeavoured to distinguish between the "combined," "capillary," and "free" water by observing the behaviour of the gels on freezing.

But even if we exclude cases of this kind, and confine our attention to dry, clean crystals of normal size, various facts are met with which suggest that Proust's view must be modified. In certain regions of mineralogical chemistry we almost lose sight of the principle of fixed composition. The common mineral plagioclase felspar, for instance, is assigned a formula

$$m \; NaAlSi_3O_8 + n \; CaAl_2Si_2O_8,$$

although it is a homogeneous crystalline body. Such cases, which are very common in mineralogy, are seldom considered by the advocates of the law of definite proportions.

About 1913-1914 Kurnakow, as a result of his study of alloys, advanced views which amount practically to the revival of the Berthollet doctrine. Since that time, further work on alloys has served to throw new light on this question. The object of the present paper is, firstly, to rotate the present metallographical position from a standpoint somewhat different from that adopted by Kurnakow, and, secondly, to show that Kurnakow's contention is not confined to intermetallic compounds, but extends also to compounds between metals and non-metals (*e.g.*, metallic oxides, sulphides, and chlorides).

From a study of solid solutions in alloys; oxides, chlorides, and sulphides; and the

hardness of mixed crystals, the author draws the *following conclusions*:—

1. Many of the series of solid solutions met with in alloys show a maximum *melting-point* (*i.e.*, a maximum *thermal stability*) at a composition indicated by a simple *atomic formula* (*e.g.*, AuMg); it is customary to describe this member of the series as an "inter-metallic compound," and to regard it as the parent of the series. But in cases where there is a maximum *hardness* (*i.e.*, maximum *mechanical stability*) at a composition indicated by a simple atomic formula (*e.g.*, AgAu), or where there is an abrupt change of chemical behaviour (a *parting limit*), it is not at present customary to apply the word "compound." Clearly the use of the word "compound" is one of convenience; there is no definite distinction between a compound and a mixed crystal. The compound is in many cases merely a member of a continuous series of solid solutions possessing greater stability and therefore greater importance than other members; the fact that the maximum stability usually occurs at a composition expressible by a simple formula is often capable of a physical explanation.

2. Many of the oxides of those metals which possess more than one valency have a variable composition; the decomposition pressure varies gradually with the oxygen content, thus distinguishing these solid solutions from mechanical mixtures. There is a continuous series (or, according to some chemists, a broken series) of iron-oxygen crystals varying in composition between Fe_3O_4 and Fe_2O_3: pure Fe_3O_4 and Fe_2O_3 may be regarded as the "end-members" of the series. Likewise homogeneous bodies of variable oxygen-content occur among the oxides of platinum, iridium, nickel, molybdenum, tungsten, and possibly silver, lead, and thallium. Among the chlorides we have a series of homogeneous *substances with* $TlCl_3 . 3TlCl$ *and* $TlCl_3$ *as* end-members, whilst crystals of variable composition exist in sub-chlorides and sub-bromides of bismuth; among the sulphides we have a series ranging from Cu_2S to CuS: pyrrhotite is another case of a sulphide of variable composition, whilst mixed crystals also exist in the sulphides of nickel and cobalt.

3. The cause of the maximum hardness of metallic mixed crystals at the equi-atomic composition is discussed in an appendix.

I wish to thank Mr. A. J. Berry for his kindness in giving me early information regarding the results of his work on the oxides of thallium.

The Formation of Anomalous Liesegang Bands, by F. G. Tryhorn and S. C. Blacktin.

When the stratified precipitates known as Liesegang bands are produced by the diffusion of an electrolyte into a gel containing a second electrolyte of low concentration, it is found in general that the distance between successive strata increases as diffusion proceeds.

A reaction has been found by Hatschek, however, which presents anomalies. This is the production of lead chromate by the interaction of lead acetate and potassium chromate or dichromate. Stratified precipitates resulted from this reaction when a 5 per cent. solution of potassium dichromate diffused into a 1 per cent. agar gel containing 0.1 per cent. of lead acetate. Under these conditions normal bands were produced for a short way below the dichromate-agar interface, the distance between successive bands increasing. As diffusion proceeded, however, a second series of bands was observed. These secondary bands formed at intervals between the normal bands, and were distinguishable from them by greater width, and the distance between consecutive members of the secondary series decreased. By varying the concentrations of the reactants and by eliminating temperature changes it was shown that the production of these secondary bands could not be attributed to any changes of concentration brought about by unequal diffusion, or to temperature variations.

The time of diffusion occupied several days, and the external factor which naturally varied over this period was the light intensity. Further experiments showed conclusively that the secondary bands were to be attributed to the variations of this factor.

The mechanism of the production of these anomalous bands was obscure. A chemical origin in the reducing action of the gel under the influence of light was ruled out on the grounds that although reduction has been recorded by gelatin and gum arabic, agar is not known to possess reducing properties. A second possible action of the light would be upon the rate of diffusion of the electrolyte in the colloid medium. This was investigated by observing the limits of diffusion, under varied conditions of illumination, of potassium di-

chromate into an agar sol free from lead acetate. No variation in the limits of diffusion could be detected. An investigation of the size of the granules of the precipitates threw no light on the mechanism of the phenomenon.

In seeking an explanation of the influence of light on the formation of Liesegang bands, several factors must be considered. In addition to temperature changes, variations in diffusion velocity or concentration, and chemical effects, a change in the velocity of crystallisation may be effected by incident light. With the exception of the last effect, these possibilities are negatived by the experiments of Hatschek. The only experimental evidence bearing on the last alternative is to be found in some results of Traütz and Anschütz, and is inconclusive.

An apparent increase in velocity of crystallisation would be caused by an increase in either of the two factors, rate of nucleus formation and rate of growth of the nuclei. Considering the work of Traütz and Anschütz, it would seem that evidence is afforded for the acceleration by light of nucleus formation in the cases of particular salts, but that there is no evidence for any effect of light on the rate of growth of the nuclei once they are formed. It will be shown later that the former effect would account for the formation of anomalous bands in the Liesegang phenomenon.

The present investigation was undertaken to determine whether the production of anomalous bands of lead chromate is a unique case, or whether the effect is a general one, and further to determine whether the influence of the light could be attributed to a change in the rate of nucleus formation in the precipitation process.

Two further examples of the production of anomalous Liesegang bands were cited in addition to the case of lead chromate in agar gels first noticed by Hatschek.

It is further shown that the substances formed in these three reactions crystallise from the respective gels more readily in the light than in the dark.

Such an effect is sufficient to explain the formation of anomalous bands in these instances, and a tentative suggestion of the mechanism of the process is advanced.

Papers read:—

On a Relation between Surface Tension and Density, by ALLAN FERGUSON, M.A., D.Sc.

In a paper read recently before the Faraday Society, Dr. Macleod has shown empirically that, for a number of unassociated liquids

$$\gamma = C(\rho_l - \rho_v)^4$$

where γ is the surface tension of the liquid at any temperature, $\rho_l - \rho_v$ the difference between the orthobaric densities of the liquid and the vapour at that temperature, and C a constant which is independent of the temperature. The relation holds with considerable accuracy over a wide range of temperature, and it becomes a matter of interest to examine the exactness and the physical meaning of the relation, and especially to determine the connection of the constant C with other physical constants of the liquid.

There exists an almost endless variety of such empirical formulæ.

For the purpose of this paper the power law and the Eötvös equation are sufficient guides.

The power law is by no means so widely used as it should be.

Some little time ago, desiring a form of equation which should more accurately represent the results of experiment than the evergreen

$$\gamma = \gamma_0(1 - at),$$

I tried independently the formula next in order of complexity, namely:

$$\gamma = \gamma_0(1 - bt)^n$$

If we do not attempt to force the value of the constants b and n, but determine the values appropriate to each liquid from a few measurements of γ and t made at ordinary temperatures, it will be found that the value of b represents the reciprocal of the critical temperature with an accuracy comparable with that of the experimental determination of t_c.

The agreement between the observed and values calculated by a development of this, is as close as can be expected, and the author feels justified in stating that the relation between the surface tension and density of any unassociated liquid is given very fairly by the equation:—

$$\gamma = \Delta \cdot \frac{\theta_0}{M^{\frac{2}{3}}\rho_c^{\frac{10}{3}}}(\rho_l - \rho_v)^4$$

where Δ is a constant independent of the nature of the liquid.

URUGUAY.

TENDERS INVITED FOR LUBRICATING OILS.

The British Vice-Consul at Montevideo reports that the State Electric Light

Works at Montevideo are calling for tenders to be presented by August 22 for various lubricating oils. A copy of the specification, general conditions of tender, etc. (in Spanish) can be seen at the Department of Overseas Trade (Room 52), 35, Old Queen Street, Westminster, S.W.1.

In the House of Commons recently, Sir John Simon asked the President of the Board of Trade whether he was aware that Messrs. A. E. & E. Becker, of Howden Clough Mills, Birstall, near Leeds, applied on April 16 last to the Dyestuffs Advisory Licensing Committee for a licence to import one ton of Diamond Black P.V., and that the licence was refused on the ground that Diamond Black P.V. was available under the reparation arrangements; that the lowest price at which this dye could be supplied from reparation stock was 2s. 8d. per lb., and that this price was fixed by the Board of Trade, whereas this firm could have obtained this dye under an import licence at 2s. per lb.; and whether he would take steps to enable the British dyeing industry to obtain the best dyes at the lowest price, in order that it might not be handicapped in competing with the products of other countries.

Sir Philip Lloyd-Greame replied: The application for a licence was refused on the ground that large quantities of the dyestuff mentioned were available in reparation stock. As regards the price charged, the ordinary procedure has been followed, and the matter referred to the Price Committee which advises the Board of Trade; but that Committee, which consists of two representatives each of the dye-users and dye-makers, has not up to the present recommended any change in the price charged for this particular dyestuff.

The Department of Mines, Canada, has issued a *Summary Report of Investigations made by the Mines Branch, 1921*.

This Report contains much information of scientific interest, especially concerning the possibilities of using the vast natural resources of this Dominion.

Brief accounts are given of the following: [illegible]mont amber (Alfred W. G. Wilson). [illegible]on industry (A. H. A. Robinson). [illegible]oxide pigments in Ontario (Howells Frechette). Investigations of miscellaneous non-metallic minerals (H. S. Spence). Alkali deposits of Western Canada (L. H. Cole and F. M. MacNiven). Cretaceous shales of Manitoba and Saskatchewan: their economic value as a possible source of petroleum (S. C. Ells). Oil shales of Canada (S. C. Ells). Chemical products from natural gas (R. T. Elworthy). In the Chemical Division, the possibility of producing methanol (methyl alcohol) and formaldehyde from natural gas, is discussed by R. T. Elworthy; and chemical and physical characters of bentonite, by E. A. Thompson and A. Sadler.

In his paper, Mr. Elworthy shows the possibilities of natural gas as a raw material for chemical products of great value. This is a sufficient argument for the expenditure of time and money for the conservation and development of this natural resource. The Mines Branch laboratories are well equipped to carry out much of this work, though the successful solution of these problems will be obtained only by the widest exchange of opinions and by co-operation with the natural gas and chemical industry.

A general review of ore-dressing occupies over 100 pages. Other reports from the Fuels and Fuel Testing Division, Ceramic Division, and Road Materials Division.

The report is illustrated with photographs, drawings, and diagrams.

CORRESPONDENCE.

To the Editor of THE CHEMICAL NEWS.

SIR,—My attention has been called to *Science Abstracts*, No. 305, of May 25, in which an extract is given under No. 648, page 261, Micro-Telescope and Super-Microscope.

In reading this extract, I would like to point out that a very serious misstatement is made, one quite at variance with what was actually said by me. I refer to the fourth sentence, in which I am made to say that the "collector" forms an image of a microscopic object *at a position of the stage of the microscope*. This should read, "at a position *beyond* the stage of the microscope," quite a different thing altogether.

The article referred to appeared in *The Chemical News*, Vol. CXXV., pages 353 to 355, December 15, 1922.—Yours, &c.,

F. DAVIDSON.

29, *Gt. Portland Street, London, W.*
June 25, 1923.

NOTICES OF BOOKS.

Thermodynamics and the Free Energy of Chemical Substances, by G. M. LEWIS and M. RANDALL. Pp. XXIV. + 653. Messrs. McGraw-Hill Publishing Co., Ltd., 6 and 8. Bouverie Street. London. E.C.4. 1923. Price 25s. net.

This book contains a great deal of material, which is presented in an attractive and useful form, the main idea being to treat the science of thermodynamics so as to make it readily applicable to quantitative and numerical calculations. The authors develop a variety of methods of treatment owing to the requirements of the cases, and thus the reader will find chemical, algebraic, arithmetical and graphical treatments, which should be helpful to him.

The book is up-to-date. For example, the entropy of "electron gas" is indicated, also the thermal ionisation of metals. Saha's work in connection with stellar spectra is briefly noted. On page 464 the atomic entropies per gram-atom of 76 elementary substances are tabulated. Carbon (diamond) has the lowest numerical value, while iodine, xenon, cæsium, mercury and niton, as gases, are almost equal to one another, and they have the highest values listed.

The applications of thermodynamics to chemical reactions are treated at length, and it is profitable to study these, as they may afford a means of determining the limits to theoretical yields so that, in commercial developments contemplated, errors need not be made. Thus a saving of useless expenditure may be avoided. The book should prove of great value to the advanced student and the practical worker requiring fundamental knowledge of the thermodynamics of chemical reactions, and as a work of reference and study it is a most valuable one.

As regards diction, there is a clearness of statement we admire. For example, on page 606 the authors state that "If a substance is capable of undergoing a spontaneous change, and if by this change the substance is heated so that the process accelerates itself after once starting, the substance belongs to the class of explosives." It is of interest to note here that the radio-atoms are not explosive in this sense.

There is one minor fault which we think should be observed generally in connection with books intended for reference, and that is the use of special words having a particular meaning peculiar to the author, as the reader is apt to forget their significance, and he has then to read back to find out what they mean. It should be realised that anything that saves time in reading enhances the value of a book. An example will illustrate our meaning here. On page 50 it is stated that "the deviations from whole numbers of the atomic weights of *pure* isotopes (referred to hydrogen) measure the energy changes in the synthesis of the elements." The italics are ours. Not knowing the authors' use of the word *pure*, the reader is apt to ask himself—What are impure isotopes? The definition, however, of pure substances and solutions is given on page 10, which shows that the authors have been thorough in their work; but still we think that a few extra words in cases of this kind would be helpful to the reader. It is true that the index is useful in this respect, but it is doubtful whether it would always be of assistance.

The Chemistry of the Inorganic Complex Compounds, by DR. ROBERT SCHWARZ. Authorised Translation by LAWRENCE W. BASS, PH.D. Pp. X. + 82. London: Messrs. Chapman & Hall, 11. Henrietta St., Covent Garden, W.C.2. 1923. 8s. 6d. net.

The fact that numerous double salts and complex inorganic compounds have been prepared, which do not easily accord with the simple conceptions of valency as originally defined, has led numerous authors to extend and alter these conceptions.

Probably the greatest advance in this direction is that of Werner, who put forward in 1908 his Co-ordination Theory to account for the existence of double and complex salts, basing his theory on some classical researches on the Cobaltamines, etc.

His volume, *Neuere Anschauungen auf dem Gebiete der Anorganischen Chemie* (the second edition of which was translated into English by Hedley, 1911), gave a full account of the co-ordination theory, but possesses the disadvantage, from the students' viewpoint, of being difficult to follow. It is for such students that Prof. Schwarz has written this present volume, which is intended as an introduction to the study of complex inorganic compounds.

It is shown how the valency theory, which hold for the explanation of the formation and behaviour of all simple chemi-

cal compounds, does not hold for compounds of higher order, *i.e.*, compounds formed by the union of two or more saturated molecules.

These are divided by Prof. Schwarz into *addition compounds* and *penetration compounds* (Einlagerungsverbindungen). The former include true double salts, like K_2PtCl_6, cobaltinitrites, etc. Such substances as the metal ammines and hydrated salts are examples of penetration compounds.

The book concludes with a useful historical survey of the subject, and constitutes a further interesting contribution to the literature of this subject.

Electrons, Electric Waves, and Wireless Telephony, by J. A. FLEMING. Pp. VIII. + 326. The Wireless Press, Ltd., 12 & 13, Henrietta Street, Strand, London, W.C.2. New York, Sydney, Melbourne, Madrid, Genoa, and Amsterdam. 1923. Price 7s. 6d. net.

Addressing ourselves particularly to chemists, they will find in this book that Wireless is not so far removed from chemical problems as they might suppose. Prof. Fleming devotes a considerable portion of his book to atomic theory. Much fundamental science whether, for example, it be the chemical reaction, the dynamo, or the thermionic valve, as used in wireless, have in common one agent of great and wonderful activity, namely, the electron. In this book the reader will find many scientific lines of research and study blended in a most fascinating manner. We cannot do better than list the main contents:—Surface waves and wave production; waves in air; architecture of atoms; electro-magnetic fields, forces and radiation; production and detection of long electric waves; telephony and speech transmission; principles of wireless telephony; index.

As a striking instance of the practical side which is evident throughout the book, the following, from page 305, will serve as an example:—"A still more important improvement, however, has come from the United States, in the form of a thermionic valve, of which the greater part of the bulb is formed of sheet copper. The copper not only forms part of the bulb, but also constitutes the anode cylinder, and can be kept cool by cold water. The foundation of this improvement is the technical discovery of a method of sealing copper to glass in such fashion that it does not crack away on cooling. expensive metal, platinum, has hitherto been used for wires which must be sealed airtight through the wall of the glass bulb is that it possesses three essential qualities for this purpose. First, it has nearly the same coefficient of expansion with heat as lead glass. In the second place, hot platinum is "wetted" by molten glass; that is, it sticks to it; and lastly, platinum is not oxidised when heated in a blowpipe flame, but retains a bright and clean metallic surface. No other metal has been found which possesses all these properties, but the discovery was made some years ago that if copper is kept unoxidised in a flame containing reducing gas, it is, when very hot, "wetted" by molten glass, which sticks to it. Copper, however, has not the same coefficient of thermal expansion as glass, and the only way to attach a copper tube to a glass tube of the same size is to give the copper a sharp knife edge. If, then, a sort of copper thimble is made, closed at one end, but with the edge of the open end made sharp like a knife, this thimble can be sealed airtight to a glass tube of the same diameter as the thimble, and the joint will not crack away in cooling, and can be made vacuum-tight. The glass tube terminates in a re-entrant portion through which are sealed wires, to which are sealed the wires which carry the ends of the filament of the valve and also the leading-in wire for the grid."

Much of this book will appeal to the general reader having interest in modern scientific developments. The book is not without interesting theoretical matters of fundamental importance. A short but lucid account of the quantum theory is sketched. All chemists should possess the book and study it carefully, for it makes clear many things which enter into modern chemical and physical problems.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

14663—Rhenania Verein Chemischer Fabriken Akt-Ges.—Production of salts of barium and strontium soluble in water. June 4.

14954—Urfer, C.—Synthetic production of ammonia. June 7.

Specifications Published this Week.

[illegible]

THE CHEMICAL NEWS,

VOL. CXXVII. No. 3300.

SULPHUR DYES.

By R. F. Hunter, F.C.S.

The first of this important class of dyes was prepared by Croissant and Bretonniere n 1873 by heating various kinds of organic matter such as sawdust, bran, straw, etc., with sulphur and alkaline polysulphides. This dye was called Cachou de Laval, and received quite a large application as a cotton dye, despite its unpleasant odour. The substance dyes cotton green and yellow shades—these on exposure to atmosphere undergo oxidation to brown shades. These brown colours are exceedingly fast, both to light and to soap..

This dye remained the sole representative of its class until some twenty years later a French chemist, Raymond Vidal, prepared the famous Vidal Black. He obtained it by fusion of sodium sulphide and sulphur with p-aminophenol.

The dye by far surpassed any other cotton dye of its kind, save aniline black, in fastness to light, washing and boiling with acids, and aroused considerable interest; so much so that various organic bases were used with sulphur, and hence arose the sulphur dye industry. The extreme fastness of the first two members gave the impression that the remaining members of the family would possess similar properties, but bitter disappointment doomed this hope.

There are at present two methods of preparation employed, viz.:

(1) Baking,

(2) Refluxing of boiling solution.

The latter yields the best results. The usual method of procedure is to dissolve Na_2S crystals in water, add sulphur flowers, then the base, and boil under a reflux condenser until the desired stage is reached; then filter, wash and dry. The process must be watched, since sulphur dyes, it should be remembered, are complex condensation products, and if heating is carried too far, weird results appear. During the reaction, torrents of H_2S and NH_3 are evolved, and hence the preparation should be carried out in a good draught.

Very little is known as to the chemical constitution and composition, even of the sulphur dyes, and we can only surmise that they probably contain a large number of thiazine rings and possibly mercaptan groups.

Blue and black dyes are usually derived from thiodiphenylamine, whilst yellow and brown are obtained from thiazoles. Immedial yellow is produced by fusion of dehydrothiotoluidin with sulphur, and probably consists of complex mixture of the higher primulins.

$$NH_2C_6H_3\left\langle{S \atop N}\right\rangle \text{ etc.}$$

The red type of dyes are mostly unsatisfactory, and are derived from azines, and have been shown to contain an unchanged azine ring.

Vidal regarded his black from atmosphere as

$$C_6H_3(OH).NH.S.(CH)_2SNH(CH)_2$$
$$NHSC_6H_3OH$$

and further by carrying out the reaction at a lower temperature he obtained dehydrothiodiphenylamine.

$$C_6H_3(OH)NHS\ C_6\ H_3(OH).$$

Immedial pure blue on oxidation and bromination gives

$$C_6H(Br)_2N(CH_3)_2NSC_6HBr_2:O.$$

(tetra bromodimethyl aminothiazine).

The formula

$$C_6H_2(CH_3)NH_2NSC_6H_3S,$$

has been assigned to Immedial Indone obtained from a mixture of o-toluidin and p-aminophenol.

A point worthy of note is that Green, by oxidising a mixture of p-diamine or p-amidophenol with a large excess of $Na_2S_2O_3$ and solid $K_2Cr_2O_7$, obtained di or tetra sulphonic acids.

A few of the commoner sulphur dyes might now be described:

Immedial Yellow is prepared from Na_2S and *m-tolylene diamine*. If heating is carried too far, orange shades result.

Thional Brown is prepared by condensation of arylamino derivatives of b-naphthoquinone with sodium polysulphide, temperatures 240-280° C.

Cotton Brown is obtained from nitro diphenylamine and sodium polysulphide.

Eclipse Brown is made by heating tolylene diamine and oxalic acid with polysulphide.

Immedial Black is obtained from *p*-hydro-*o*-*p*-dinitrodiphenylamine, which results from condensation of p-aminophenol and dinitrochlorbenzene.

Sulphur Black T Extra made from dinitrophenol.

Thiophenol Black T Extra from dinitrophenol.

Immedial pure blue C is made from p-dimethylamine p-hydroxydiphenylamine.

Immedial blue C from *p*-hydroy-*o*-*p*-dinitrodiphenylamine.

Immedial Indone from the indone $NH_3C_6H_4N:NC_6H_4:O$.

Indo. carbon SSF is by far the most important blue, and is prepared from the indophenol produced by condensation of carbazole and nitro phenol.

Italian Green is produced by adding copper sulphate to the melt obtained from p-nitrophenol and sulphur (Vidal's black).

Immedial Green is prepared in the same manner from the indophenol. A red sulphide dyestuff is obtained from amino hydroxy phenazine.

AN EXPLANATION OF THE THEORY OF THE ROTATION OF THE ATOMIC NUCLEUS.

Part III.

By Herbert Henstock.

The hydrides, halides and hydroxides described in Part II. of this series were chiefly concerned with simple co-valencies or electro-valencies where single bonds came into play, and consequently did not present the difficulties which will be met with in oxy compounds, where not only double bonds, but even distortion of the octet are encountered.

A double bond might occur as described in Part I. of this series, but it might also occur as shown in Fig. 1.

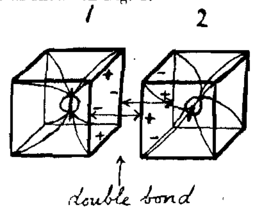


Fig. 1

Most double bonds would probably be formed in this fashion. Cube No. 1 has its nuclear poles in the plane of the paper, No. 2 has them almost at right angles to the two negative edges in each atom, so that when such a bond opens into a single bond it may do so at any edge.

Here the double bond is not formed on the faces of the cube, which lie at right angles to the nuclear poles, but on any of the four faces, which are parallel with the poles: as a consequence of this there cannot be more than four such double bonds operating from any atom, which has an undistorted octet.

In double bonds one or more electrons may be displaced and may occupy different corners of the octet from those which they normally occupy in the atom: the same thing will also occur in a treble bond.

Distortion of the octet will be considered here only as from the cube to the tetrahedral form, either partly or wholly as a shrinkage, but it is possible that the octet may exhibit other forms of distortion in shrinkage or expansion, as, for instance, to the octohedron. In shrinking from the cube to the tetrahedron, one or more corners of the cube disappear, leaving triangles which will constitute tetrahedral faces.

Oxides.

Group I.—General Types Li_2O, Na_2O, K_2O, etc., are shown in Fig. 2.

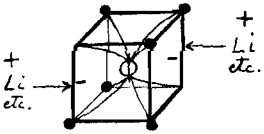


Fig. 2

Na_2O_2 will be constituted like H_2O_2 (see Part II.) thus:—

```
 +    -    +
Na - O - O—
          |
         +Na
```

the molecule having the same weakness in one of the oxygen atoms (Rule 2) which occurs in that compound. K_2O_4 will have a somewhat similar construction, as:—

```
+   -   +
K - O - O—
        |
    + -
    O - O+
   +
    L
```

weakness. Copper is one of those elements, which may have varying numbers of electrons in its octet, see Bury (*J. Amer. Chem. Soc.*, 1921, XLIII., 1602), so that its three oxides will be constituted differently: Cu_2O will conform with Fig. 2 where it has only one electron in its octet: CuO with Fig. 3 with two electrons, and CuO_2 with Fig. 5 with four electrons: its chlorides and other salts will likewise have normal structures.

Gold has similar properties to copper with respect to its octet, so that AuO will conform with Fig. 3. and Au_2O_3 with Fig. 4.

The reasons for the instability of the cuprous salts and also of most of the salts of gold do not seem clear; it is possible that the cause may be due to the change in the numbers of electrons in the octets of these elements, which brings about stable or unstable arrangements in their atoms. Silver peroxide, Ag_2O_2, will probably have a composition similar to that of sodium or hydrogen peroxides, since when Ag_2O_2 is slowly acted upon by water it yields H_2O_2. The instability of Ag_2O_2 is therefore accounted for.

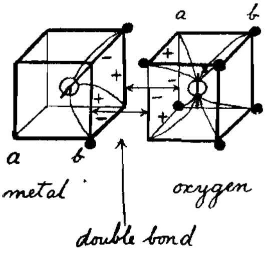


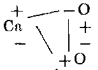
Fig. 3

Group II.—General types, BeO, MgO, CaO, ZnO, etc., are represented by Fig. 3.

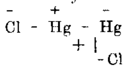
In the octet of the metal the electron at (b) has travelled from its normal position (a) and a similar action has occurred in the oxygen octet.

The stability of these oxides to heat is very great, but the bond is only stable to heat and not to the electricity of other atoms, for it is weak enough to be attacked by such a neutral substance as water, which fact is a good demonstration of the *difference between the actions of these two* forces.

The peroxides of the types CaO_2, BaO_2, etc., will have a somewhat analagous constitution to that of hydrogen peroxide, since they can be formed by its action upon the hydroxides of these metals: their instability is thus accounted for. They will be constituted as follows:—



Mercurous salts will be abnormally formed. Mercurous chloride, as an example, is not so stable as the mercuric salt; since its vapour density agrees with the formula Hg_2Cl_2 (see Smith and Menzies, *J. Amer. Chem. Soc.*, 1910, XXXII., 1434, and *Ann. Physik*, 1910, XXXIII., 979) it will be represented by



Group III.—General types, B_2O_3, Al_2O_3, etc., are constituted as shown in Fig. 4.

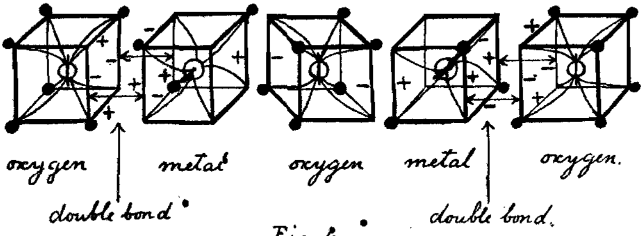


Fig. 4.

where three oxygen atoms show the same and *are all quite regular.*

Group IV.—General *types*, CO_2, TiO_2, SnO_2, etc., are represented by Fi

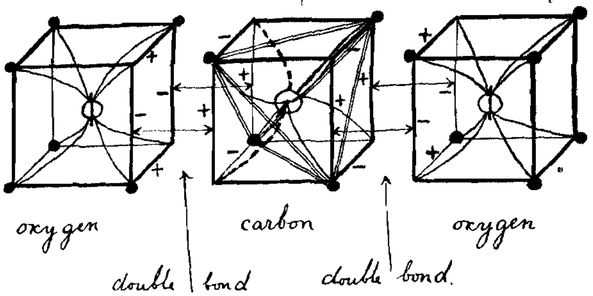


Fig. 5.

The great stability of silica is not apparent from the theory of nuclear rotation.

The case of carbon monoxide presents more difficulty than that of the di oxide, but an explanation may be found by taking into account *the partial distortion of the* carbon octet. If the uncombined carbon atom be taken as possessing the form of the tetrahedron and the uncombined oxygen atom that of the cube, then when two such atoms approach one another under suitable conditions for union, we should have a postulation somewhat after the manner contemplated *in Fig. 6.*

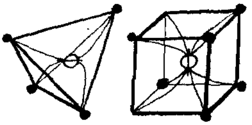


Fig. 6

There is in this case no edge or face for union, which will correspond in each atom: if, however, the carbon octet begins to form itself around the tetrahedron, but on one side *only where one edge of the tetrahedron* expands into a cube face, we have a state of things as shown in Fig. 7.

The dotted lines indicate the alteration in shape which the figure will take. We

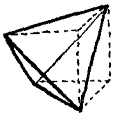


Fig. 7

can now write the complete formula of bon mon oxide as follows:—

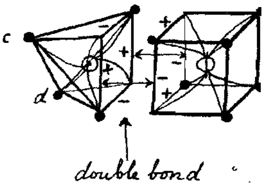


Fig. 8

There are here no free valencies in ei the carbon or the oxygen atoms until rest of the distorted cube is opened c which would occur when another group

[1] *The reason for the inclusion of tetrahedron will appear later.*

atom, say, of oxygen, came in contact with the carbon under suitable conditions for union; the result would be as shown in Fig. 5, in which the dotted lines represent the new lines of force brought into play; these pass out through the middle of the two tetrahedral faces. The tetrahedron has been retained in Fig. 5, in order to show its bearing on the whole thing. The new lines of force may be taken to be halves of the old lines of force running to the electrons (c) and (d) in Fig. 8.

When lines of force run out to the corners of the octet of an atom to positions where there are no electrons, and when no union occurs with another atom, the first atom will be in the activated or nascent condition; if union occurs, these lines of force remain in position, but when union does not take place they may shrink into the nucleus or they may coalesce with the lines of force running to neighbouring electrons, in which case distortion would occur.

This view of the matter may seem, at first sight, a little bizarre, but when it is remembered that a transition of this kind is only a passage from hemihedral to holohedral types, well known in crystallography, there seems no reason why it should not occur in such cases as this, the only difference being that it might take place in stages. It explains both the possibility of the existence of carbon mon oxide, as well as its instability to certain reagents such as oxygen, chlorine, etc. (see rule 7), since the opening up of the second cube face in the carbon atom will take place more readily after the first has been formed. At the same time the double bond in CO is a normal one, and this, together with the likelihood that a small quantity of electrical energy or effort would be necessary to open up the distorted carbon octet, gives CO enough stability to exist, although only half of the normal valencies of the carbon are saturated. This substance is another instance of great stability to heat but not to the electricity of other atoms.

C_3O_2 will be normally formed like CO_2, thus:—

$$\overset{+}{\underset{-}{}}\quad \overset{+}{\underset{-}{}}\quad \overset{+}{\underset{-}{}}\quad \overset{+}{\underset{-}{}}\quad \overset{+}{\underset{-}{}}$$
$$O = C = C = C = O$$

Each double bond is composed of both negative and positive edges, as shown in Fig. 1.

As analagous cases to CO, in this group, might be cited those of the stannous and plumbous salts. The example of stannous chloride, which will be seen in Fig. 9, is a representative one.

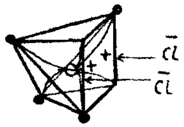


Fig. 9

This configuration explains the readiness with which the compound absorbs oxygen, since the second half of the cube is easily opened.

The tendency of the octets of the elements of this group towards distortion seems to be greater than those of most of the other groups: also quadrivalence seems to become less pronounced with increase of atomic weight, the greater number of internal electrons in the atoms of the members of higher atomic weight evidently weaken the lines of force to the electrons of their octets, thus encouraging distortion.

It cannot be thought that every atom has a full cube octet; as examples, hydrogen, the alkali metals, the alkaline earths, and the boron group have not enough electrons in their outer layers to warrant us in supposing that an imaginary cube, having only one or two corners occupied by electrons, surrounds the nucleus; these elements must naturally have *distorted* octets, and it is therefore more than likely that those elements, having larger numbers of electrons in their octets, may also exhibit distortion, even in the combined state.

Chemical Research Laboratory,
School Gardens,
Shrewsbury.

GENERAL NOTES.

THE STRUCTURE OF THE ATOM.

The issue of *Nature* for July 7 contains a special 16-page supplement, in which Prof. Niels Bohr, professor of physics in the University of Copenhagen, gives a comprehensive and striking account of the present state of knowledge of the structure of the atom.

Prof. Bohr has taken a leading part in the development of modern conceptions of atomic structure; and he devotes particular attention in his paper to the interpretation of spectra, and the main features of the properties of atomical elements on considerations of the *manner in which an atom* can be imagined to be built up by the capture and binding of electrons to the nucleus, one by one.

NEED FOR SETTLEMENT OF EUROPEAN SITUATION.

In the course of his speech at the Bradford meeting of the *Federation of British Industries*, Sir Eric Geddes said:—

"The general upward trend of trade which goes on through the centuries is, therefore, checked because of the disturbed *condition of Europe, and while I see fair* reason to hope for an upward trend in the *cycle of trade*, I can at present see nothing but blackness when I look for a resumption of the upward progression in the general level of trade shown during the last century. Therefore, as first and foremost of all measures which can be taken for the improvement of trade, and the reduction of unemployment in this country, I would put the settlement of the *European situation*. We, as a great exporting country, are worst hit of all by the present state of affairs in Europe. Our unemployment is caused by that, and I do not think that the working, trading, and banking community of the country can too insistently bring before His Majesty's Government the conviction which *I feel*—and which I believe is generally felt—that the great problems of this country would melt as mist melts before the sun, if a stabilised condition could be brought about in Europe. It is not only *the direct influence on trade that is felt*; but it has an influence on taxation, and taxation is one of the great burdens against trade to-day."

In a pamphlet issued by the United States Geological Survey* some interesting particulars are given of the occurrence of *diamonds in Arkansas*.

Stones found within the exposures of peredotite and have been mined to a depth of 20 feet, and the deposit is thought to extend to great depths. Dr. G. F. Kunz considers that the peridotite is the source of *the diamonds. The production so far does* not appear to be very great, although it is stated that it is difficult to obtain complete figures of production, some 5,300 stones are known to have been obtained.

The method of separating the stones is the same as is now practised in Kimberley, viz., working the material in circular pans having a revolving vertical shaft to which radiating arms are attached, at stated intervals the concentrates are removed and passed over grease tables to which the diamonds adhere while the other minerals are washed off. The stones are said to be mostly small, and to vary in colour from white to yellow and brown, some very fine crystals have been found.

* *Diamond-bearing Peridotite in Pike County, Arkansas, by Hugh D. Miser and Clarence S. Ross*. Bulletin 735, I.

The current number of the *Analyst* contains a paper by H. Droop Richmond on the action of potassium carbonate upon lead glass. It was found that the apparently dry salt had an appreciable action on the glass, and that the action increased rapidly as moisture was absorbed. *Both lead and arsenic were* found in potassium carbonate that had been stored in bottles containing these *substances, and the danger of the use of such* bottles as containers for this salt is pointed out.

LABORATORY EQUIPMENT.

The Council of the Society of Chemical Industry have received from the Department of Scientific and Industrial Research a request to nominate three or four members to furnish information with regard to the quality and technical range of British production of optical glass and instruments, laboratory glass and porcelain, synthetic organic chemicals, analytical reagents, and other fine chemicals. The Department had already sought the opinions of a large number of professors of chemistry, physicists, and others, but appeared to have addressed enquiries to very few practitioners in chemistry. The Council suggested, therefore, that useful opinions might be obtained from such practitioners,

and they have forwarded the names of Mr. W. T. Burgess, Dr. J. T. Dunn, Dr. Bernard Dyer, Mr. E. W. Voelcker (Hon. Treasurer), together with that of Mr. H. W. Cremer, who is responsible for supplies in the chemical department of King's College, London.

The Council have also appointed a Committee to consider the proposal from the National Physical Laboratory that the work of the Joint Committee for the Standardisation of Scientific Glass-ware should be brought under the ægis of the Institute of Chemistry. The Council hold that the proposal is desirable on general grounds, but in order to obtain more detailed information with regard to the probable and possible activities expected of the Institute in this connection, they have appointed a Sub-Committee consisting of the President, with Dr. Brady, Dr. Bernard Dyer, Dr. J. J. Fox, Sir Herbert Jackson, and Mr. E. W. Voelcker (Hon. Treasurer), to confer with representatives of the National Physical Laboratory, the Department of Scientific and Industrial Research, and of such other bodies as the Sub-Committee may deem desirable, and to report to the Council on the proposition.

The Special Purposes Committee have appointed a Sub-Committee, consisting of Messrs. E. R. Bolton, O. L. Brady, F. H. Carr, P. H. Kirkaldy, and R. H. Pickard, to consider and investigate the present British production of filter paper.

SMOKE PRODUCTION AND THE POTTERY INDUSTRY.

By Cuthbert Bailey, of the Pottery Manufacturers' Federation.

The man has yet to rise who will teach industry the means to extract full value from the coal it burns; invention after invention has been recorded at the Patent Office, but still our industrial centres lie under their black mantles.

That the past has been wholly blameless few manufacturers would contend, but bitter and costly experience has taught the wisdom of caution.

But, oblivious of past and present endeavours, there is arising a type of legislator who hesitates not to impeach every industry of reckless waste, and manufacturers generally of wallowing in content and inaction, and who roundly accuses local governing authorities (in the words of a recent public speaker) of being "influenced too much by the selfish considerations of their manufacturing friends." These men, with their perambulating minds, with their power of generalisation and reducing masses of evidence to mere paradoxical phrases, are active to-day with an interrogative eye-glass, and, as a consequence, legislation is now proposed that threatens the very life of some of the nation's industries.

As a few years' dissipation will break the continuity of will and the sequence of intellect of any man, so would premature legislation react on industry.

Industry invites investigation — though investigation by duly qualified experts—under the sure conviction that any unprejudiced enquiry would dispel the insinuating delusions now being broadcasted.

Every industry has its essential processes and its own inherent limitations; all carry their own signals and the expert alone knows the cyphers. Of all industries the manufacture of pottery may be claimed to be the most complicated and intricate, and it is probably realised by few outside the pottery areas that the great bulk of the smoke emitted is not made in raising the necessary power to drive the machinery for its production, but is made in the various "baking" stages to which all pottery must of necessity be subjected in the process of its manufacture.

The first "baking" stage is that which reduces the formed clay to a durable and stable state such as will permit general handling, and the subsequent glazing and decorating. But the mixture of the various clay ingredients that form the final composition of the ware, after being brought to a dry state, possesses a water of combination that varies from 6 per cent. to 12 per cent. of the total weight of the articles themselves, and, as a "kiln" may contain each time it is fired from ten to thirty tons of pottery, according to the type of articles being manufactured (placed in the fireclay "saggars" that are piled up in bungs), it follows that from approximately 10-30 cwts. of water is to be dispersed during the initial stages of the "baking." This dispersal, if cracking, warping, staining, and even general collapse of the articles, is to be avoided is essentially a gradual process, and occupies the first 20-30 hours of the "baking"—and woe betide the manufacturer whose fireman unduly

expedites what is technically called this "*smoking period.*"

Suppose an oven holds 20 tons of clayware *carrying* 10 per cent. of combined water, two tons of water is to be dispersed, which at 500° will occupy roughly one-quarter of a million cubic feet. As this rushes into the cold air outside it is naturally condensed, and, stained by the products of combustion from the burning coal, forms a cloud of what the man in the street would call "smoke." Similar remarks apply to the water in the moist goods in the earliest stages of the firing (below 200° C.) during the so-called water-smoking period—and all this steam is further supplemented by that produced by the combustion of the hydrogen compounds of the fuel itself.

During these "smoking" periods what is called smoke is, therefore, in the main, only discoloured steam; *after their completion little smoke is emitted from a modern oven.*

But smoke itself is an essential constituent in the manufacture of the famous Staffordshire blue bricks, blue roofing tiles, and many grades of pottery. So far as our present knowledge goes it is not a mere reducing atmosphere that is in question; *decomposing hydrocarbons are required to produce the required effect.* There are further what might be called "qualities of smoke," for the results obtained with some types of smoke produce better results with than others. The old potters knew this, and *in the production of lustre effects, red "sang-de-bœuf." and other types of decorative effects,* one will find in the old literature that they attached a special virtue to smoke derived from particular shrubs, etc. Thus Piccolpassi favoured "the branches, etc., of green broom"; another recommended "rice husks," and so on. English Potters, under the lead of Mr. Bernard Moore, have during the last twenty years rediscovered the secrets of the old lustre glazes, and Chinese red glazes, and are to-day producing decorative effects that are universally acclaimed as surpassing in genral beauty any of the works of the old potters—*but let it be realised that the one essential condition for their production is a reducing atmosphere.*

Pottery manufacturers are not indifferent to the progress of public opinion on this smoke question, but let not that opinion be formed on a mendicant truth. Essential conditions of manufacture must be conformed to; while the pressure of international competition is always sufficient *to ensure* that all unnecessary waste of fuel will be constantly subjected to the closest investigation.

—*Fuel Economy Review, June, 1923.*

BRITISH *v.* GERMAN GOODS IN NORWAY.

CHEMICALS.

There is a good market for British heavy chemicals, such as bleaching powder, salt cake and soda. Good business may be done in alum for the paper trade, and there are also good prospects in aniline dyestuffs. Germany is showing signs of being unable *to deliver the goods, and there is therefore every chance of a good opening for British dyestuffs.* This also applies to fine chemicals.

—*Bulletin of the Federation of British Industries.*

23 APR 1924

NEW RAPID-REGENERATING "PERMUTIT."

One of the interesting features of the Textile Exhibition at Nottingham is the exhibit, for the first time, of the new "Permutit" *Rapid-Regenerating material for* water softening, which marks a great advance in the technique of water purification by zeolites.

The new material is named "Permutit B." Its principal difference from the ordinary Permutit lies in the time taken for regeneration. *Previously a Permutit unit was designed to soften water for 10 to 12 hours* continuously. It then required an equal time for regeneration. Where day and *night* working was the rule, this involved the use of two units.

A "Permutit B." plant softens for a shorter period, ranging from 3 to 6 hours, and is then exhausted. It can, however, be completely renegerated and put to work in under one hour. The advantages of this are obvious. One unit only is required for day and night working, as the plant is continuously in operation except during the one-hour periods in which it is regenerated. All that is necessary is sufficient soft water storage to provide for one hour's requirements, to enable one unit to be used throughout the 24 hours.

"Permutit B." uses less salt than ordi-

nary Permutit, thus effecting saving in the cost of treatment. It will be seen that the new material brings down the cost of the Permutit process considerably, by saving *one unit where continuous working is required*, and by reducing the salt consumption.

Formerly the standard and universal product employed in connection with the elimination of calcium and magnesium from water by the base-exchange principle was produced synthetically, either by furnacing or by precipitation. The "Permutit" produced in this way was always subject to certain limitations.

The latest class "Permutit," which has now been in commercial service in water softening for close on three years, and which is a non-synthetic material specially treated to increase its activity, and to stabilise its qualities, has the following advantages as against all previously employed zeolites:

(1) Free carbonic acid, which exists to a greater or lesser degree in all water supplies, has no destructive effect upon it.

(2) It is to a much greater degree immune from depreciation in structure and activity by reason of iron in the water.

(3) A rate of exchange, and, therefore, a permissible rate of flow through any given plant, of upwards of ten times that of previous Permutit materials, can be effected.

(4) A similarly rapid regeneration of the material as and when the point of exhaustion has been reached at the end of a day's run, is feasible.

(5) With the new material a reduction of from 25 per cent. to 33⅓ per cent. in the requisite weight of salt for regeneration is effected.

(6) Lastly, and this, perhaps, may be regarded as the most important advance in the art, the "commercial" phrase of "zero-hardness" which has always been employed in regard to waters softened by the base-exchange method, is literally and actually borne out by the new material.

The new softening material is put on the market by United Water Softeners, Ltd., sole proprietors of the Permutit patents in the country.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL INSTITUTION.

A general meeting of the members of the Royal Institution was held on July 2, Sir James Crichton-Browne, Treasurer and Vice-President, in the chair. The death of Sir James Reid, Bart., was reported to the meeting, and a resolution of condolence with the family was passed. Mr. R. N. Lennox was elected a member.

THE INSTITUTE OF METALS.

AUTUMN MEETING.

The annual autumn meeting of the Institute of Metals will be held this year in Manchester, on September 10-13, and promises to be an exceptionally interesting gathering. The meeting will open with the second annual autumn lecture, to be delivered by LT.-COL. SIR HENRY FOWLER, K.B.E., on *The Use of Non-Ferrous Metals in Engineering*. The lecture will be a popular one, and is open to the public, tickets being obtainable from Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

The mornings of September 11 and 12 will be devoted to the reading and discussion of papers. After an official luncheon on September 11, visits will be paid to several large works in the vicinity of Manchester, and in the evening there will be a reception at the University, when the new metallurgical laboratories will be officially opened. Following the conclusion of the business side of the programme on September 12, the afternoon of that day will be devoted to a trip along the Manchester Ship Canal, and in the evening there will be a smoking concert at the Midland Hotel. A trip to Chester has been arranged for September 13, this excursion also including a launch trip up the river Dee. For those persons intending to proceed to the British Association meting at Liverpool the same evening, the trip to Chester will be very convenient, Chester being within easy reach of Liverpool.

Reduced fare facilities have been arranged with the railway companies in connection with the Manchester meeting, and the necessary vouchers for obtaining these facilities can be obtained on application to the Secretary, Mr. G. Shaw Scott, who will be glad to send a detailed programme of the meeting to those interested.

THE CHEMICAL SOCIETY OF JAPAN.

Papers communicated to the Society:—

On the Quantitative Separation of Platinum and Iridium, by SHIN-ICHI AOYAMA.

On Contact Potentials, by SHIRO TAKEGAMI.

On a New Method for the Determination of Sulphur Contained in Iron, by TERUO ASHIDA.

THE GEOLOGICAL SOCIETY OF LONDON.

JUNE 20, 1923, PROF. A. C. SEWARD, Sc.D., F.R.S., PRESIDENT, IN THE CHAIR.

Miss P. de B. F. Bowen-Coulthurst presented a geological hammer, chisel, and satchel formerly belonging to George Bellas Greenough, first President and one of the founders of the Society. She also presented a number of valuable documents and minute-books of great historical and scientific interest, forming part of the earliest records of the Society's activities.

Dr. Herbert H. Thomas, M.A., V.P.G.S., gave a demonstration of the Source of Origin of the Stones of Stonehenge, illustrated by lantern-slides.

The following communications were read:—

The River-Gravels of the Oxford District, by KENNETH STUART SANDFORD, B.A., F.G.S.; with an Appendix on the Non-Marine Mollusca, by ALFRED SANTER KENNARD, F.G.S., and BERNARD BARHAM WOODWARD, F.L.S., F.G.S.; and an Appendix on the Mineral Analyses of the Clay- and Sand-Deposits of Wolvercote, by R. C. SPILLER, B.A.

A discussion followed.

The Deposits of Paleocene Mammalia in Belgium, by PROF. LOUIS DOLLO; Sc.D., FOR.MEM.G.S., and PROF. P. TEILHARD DE CHARDIN, D.Sc.

DR. G. T. PRIOR, M.A., F.R.S., exhibited a meteoric stone which fell at Ashdon, near Saffron Walden (Essex), on March 9, 1923.

DR. L. L. FERMOR exhibited microscopic-slides of cordierite from Indian "paralavas," pleochroic in thin section, in illustration of his remarks on Dr. C. E. Tilley's paper read on June 6.

MR. K. S. SANDFORD exhibited mammalian remains and implements, in illustration of his paper.

The next meeting of the Society will be held on Wednesday, November 7, 1923.

PETROLEUM—A SHORT HISTORY.

By J. NORMAN TAYLOR, M.S.

Petroleum and its products are in greater use to-day than at any other time in the world's history. When we consider that at present there are millions of motor cars, hundreds of thousands of motor boats, to say nothing of a steadily increasing number of other internal-combustion engines depending for their usefulness upon gasoline, kerosene and lubricating oils, the necessity of insuring an adequate supply of petroleum is obvious. Another petroleum product, fuel oil, is being consumed in increasing quantities both upon land and on the sea. Yet, while the demand for petroleum and its products is growing, the supply of crude oil is being rapidly depleted. No wonder that our statesmen and scientists are searching for a solution of the oil problem—a situation that can only be relieved by finding new supplies, eliminating waste, and adopting improved methods in refining processes.

The increasing importance of this commodity in our national economy makes the story of petroleum a most interesting one indeed, not only to those who are pursuing the study of chemistry and the allied sciences, but to all who have contact with modern civilisation.

Petroleum is a complex mixture of hydrocarbons varying in physical state from solid to gaseous, and in colour from coal-black, through brown, greenish, red and yellow, to colourless. The chemical nature of its constituents varies with the locality in which it is found, the chain bodies predominating.

Although the petroleum industry of the United States is of comparatively recent origin, the crude oil has been known from the earliest historical period and in this

country had undoubtedly been long used by the Indians.

It occurs in rocks of all ages, "from the lower Silurian to the most recent" (Merrill), and as a rule in sandstone formations. Occasionally it is found in limestones and shales. Geologic relations indicate petroleum to be of organic origin—a product derived from the slow physical and chemical alteration of ancient deposits of vegetable and animal material under the influence of heat and pressure.

For convenience, the sources of petroleum in the United States may be classified as follows:—

The Appalachian field (centreing in Pennsylvania), the Lima-Indiana field (in Indiana and Ohio), the Illinois field, the mid-continent field (centreing in Oklahoma), the Gulf coast field (in south Texas and Louisiana), the Colorado-Wyoming field, and the California field. In the midcontinent field lie various pools, groups of pools, or districts, the distinguished ones being called the Cushing pool (Oklahoma), the Healdton pool (Oklahoma), the Caddo district (north-western Louisiana), and the north Texas district.

There are about as many varieties of crude petroleum as there are oil fields. However, the refiner recognises three distinct types, noted below, each of which must be handled by different methods. The paraffin base crude similar to that found in Pennsylvania and West Virginia is essentially a light-coloured crude containing paraffin; the asphalt base crude, similar to that found in Texas and California, contains no paraffin, and is generally dark coloured, almost black; mixed base crudes, similar to those found from Ohio to Oklahoma, are essentially mixtures of paraffin and asphalt base crudes. California oils contain nitrogen and ring compounds.

Professor Charles E. Munroe, in his well-known monograph on "Petroleum Refining," states that it is not surprising that petroleum obtained in Texas, California and Ohio should differ in appearance and properties from each other and from the better known Pennsylvania oil and from that obtained from other parts of the country. He attributes this difference in appearance not only to the fact that petroleum consists of a mixture of various hydrocarbons from different acyclic and cyclic series and of hydrocarbon derivatives containing sulphur or oxygen or nitrogen or other elements which themselves differ widely in properties and appearance, but also to the varying conditions under which the petroleum is produced and to the effect due to migration.

Crude petroleum has a limited application and owes its great value to the products derived from it. It is, therefore, treated at the point of origin or is transported to an industrial centre by tank car, tank ship, barge, or pipe line. This latter mode of carriage is remarkable for its ingenuity, and we have to-day the remarkable achievement whereby vast quantities of oil are made to flow under rivers and through mountains to great refineries on the seaboard such as are found at Philadelphia, Bayonne, and Baltimore. Upon arrival at its destination the crude oil is freed from water and other sediment by allowing it to settle in storage tanks, after which it is pumped into retorts where it is submitted to fractional distillation.

This operation depends upon the principle that different liquids, at the same pressure, have different boiling points. The mixture of various hydrocarbons when submitted to gradually increasing temperature might be supposed to assume the vapour condition at the temperature of their respective boiling points and upon condensation, the individual constituents of the petroleum would be in their pure state. But such simple conditions do not obtain, since the boiling points of mixtures vary inversely as the vapour pressures. Although the composition of the vapour given off from such mixtures bears no close relation to the composition of the mixture, the vapour contains a preponderating amount of the most volatile constituent. Hence it is to be expected that when the crude oil is subjected to gradually increasing heat, the constituents are successively converted into vapour substantially in the order of their volatilities, but that the separation thus effected would not be perfect, as the oils of the higher boiling points are to some extent carried over by the vapour of those of lower boiling points.

It is evident from this that difficulties arise in the distillation of petroleum attributable to one or other of three causes: (a) to the presence of two substances, the boiling points of which are very close together; (b) to the presence of one or more components relatively in very small quantity; (c) to the formation of mixtures of constant boiling point. These difficulties have to a great extent been obviated by the use of dephlegmators similar to the Hempel column,

in which the dephlegmating column consists of a drum filled with cobble stones, surmounted by a number of tubes. A large surface is thus presented, and a more complete separation of the constituents of the crude obtained.

The distillation retorts, known as stills, are of cylindrical form, constructed of boiler plate, and are set horizontally in brick-work furnaces arranged in batteries. Stills surmounted by dephlegmators such as described above are known as "tower stills." Upon the application of heat the crude oil is converted into vapour and the vapourised oil, upon passing into the condensers, is thus brought into the liquid condition. In practice it is usual to divide the distillation into two operations, the more volatile products, naphtha and kerosene, being obtained in the first part and the residue being transferred to the tar stills and heated to a higher temperature with the object of separating the lubricating oils and paraffin. By the use of "tower stills" the entire distillation may be conducted without transfer to the tar stills, as the tower is supplied with three traps, from the first of which may be collected heavy distillate, intermediate distillate from the second, and light distillate from the third, and the still run to "maltha" or coke as desired. The streams of distillate are from time to time diverted into various tanks by the stillman. When the still temperature reaches about 325° F., the crude naphtha ceases to come over, and the stream is directed into the lamp oil tank. When that portion of the oil from which the high test oils of 120° to 150° F. fire test are prepared, is distilled off (the still temperature being about 600° F.), the fires are slackened, and if it is desired to produce a maximum amount of light products in preference to a maximum amount of the heavy lubricating oils and petroleum asphalts, the "cracking" process will be used.

The "cracking" process, whereby a considerable quantity of the oil which is intermediate between kerosene and lubricating oil is converted into hydrocarbons of lower density and boiling points, is one of great scientific and technical interest. This dissociation into simpler molecules may be brought about by pyrolytic distillation and, unless a catalytic agent is used, is due to super-heating of the boiling liquid. A considerable number of processes have been brought forward for effecting the transformation of heavier hydrocarbons into gasoline hydrocarbons, the most widely used one being that of Dr. Burton, in which the pressure which obtains is greater than the atmospheric pressure. Other processes operate at atmospheric pressure and some, as in the McAfee patent, use a catalytic material such as anhydrous aluminium chloride.

The products obtained on separating petroleum into its commercial fractions are usually purified by treatment successively with sulphuric acid and ammonia or soda, the lightest distillates being treated with about 5 per cent. by volume of the concentrated acid and the intermediate distillates with about 1.5 per cent. The treatments with acid and with alkali are conducted in agitators lined with lead and provided with an air blast and outlets for the spent chemicals and treated oils. These agitators hold from 50,000 to 150,000 gallons of oil at one charge. Concentrated sulphuric acid is thoroughly mixed with the oil by means of the air blast, and after settling the acid sludge is drawn off, the oil washed with water, then with alkali and finally brightened with fuller's earth. This treatment improves the colour and odour of the oil, and removes the aromatic and unsaturated hydrocarbons, phenols, tarry products, and other substances which lower its quality.

The acid sludge is diluted with water to separate the oil dissolved in it, and usually is treated to regain the acid used in the manufacture of fertilisers, or it is concentrated for re-use in the refinery. The oil which separates on treating this acid sludge is called "acid oil," and is, after appropriate treatment, used to some extent as a substitute for ichthyol.

Oils high in sulphur, like the Ohio oils, receive a special treatment devised by Frasch. The first distillation is conducted in the ordinary way, and the distillate subsequently pumped into another still provided with a mechanical stirrer and redistilled in the presence of an excess of finely divided oxide of copper, the contents being kept thoroughly mixed by the revolving apparatus. The second distillate is practically free from sulphur, and is treated in the usual way with acid and alkali. The residue in the still, consisting of a mixture of tar and copper oxide, is drained and pressed and the pressed copper compound is revivified through roasting and used over again.

The residue from the kerosene distillation is worked up into lubricating oil and para-

ffin by distilling with superheated steam to prevent dissociation of the hydrocarbons. This steam distillate is then treated with successive portions of sulphuric acid and of alkali, then cooled by passing through a tubular cooler, when the paraffin crystallises out and is separated from the oil by means of filter presses. Both the lubricating oil and paraffin are further refined by filtering through fuller's earth or animal charcoal.

Petrolatum (known also as cosmoline and vaseline) is obtained by the careful distillation of selected grade petroleum carried on in vacuum stills. Liquid petrolatum may be prepared from the lubricating oil of fraction of certain oils and is composed essentially of the naphthene hydrocarbons.

A large number of physical and chemical tests are applied to the raw materials and manufactured products. The determination of the specific gravity is one of the tests that is considered important in every product from the lightest to the heaviest. This is generally determined by means of the hydrometer and is expressed in degrees Baumé.

The specific gravity and range of boiling points are the tests chiefly applied to the light petroleum products, some of which are commercial "pentane," used extensively as a standard of light in photometric work; petroleum ether and ligroin, both of which are used as solvents for fats, oils, waxes, and certain resins; 76° gasoline; deodorised naphtha; stove naphtha; varnish makers' and painters' naphtha, and motor spirit. The boiling point limits of these light products are being extended from time to time, so that it is impossible to define them accurately.

Kerosene is examined as to colour, odour, flash point and fire test, as well as to burning quality, viscosity, composition (as ascertained by fractional distillation) and sulphur content. The flash point is determined for the purpose of ascertaining the inflammability of the oil. There are several instruments in use for this determination, chief among them being the Abel tester, Saybolt's electric tester, Tagliabue's open and closed cups, the Elliott cup, and the Bureau of Mines tester.

Lubricating oils are of great variety, and the requirements vary with the purpose for which they are used. All should have high burning points. Viscosity is the most important index in evaluating a lubricating oil and for those used in internal-combustion engines the "carbonising number" is a valuable consideration. The "chill," or temperature at which solid hydrocarbons are deposited, is also important.

Petrolatum and paraffin are examined principally for their melting points. Petrolatum is used extensively as a basis for ointments. Liquid petrolatum is used as a laxative and as a vehicle for substances used in the treatment of mucous membranes. Paraffin is used for a number of purposes, as in the arts and in the manufacture of candles, and is sold in several grades. The tarry residual products, certain types of which are sometimes called "maltha," are used extensively in road building. Petroleum coke is used for fuel, but since it contains very little ash and much "fixed carbon," it is used more extensively in the manufacture of electric light carbons.

These are but a few of the products which petroleum is furnishing us to-day. Upon the establishment of this industry only a few generations ago, the main product was illuminating oil, and remained so for three decades. Materials, such as gasoline, fuel oil and lubricating oils, which were then considered as by-products—in the sense that by-products are defined by Professor Munroe, namely, as "substances or results obtained in the operation of a specific process in addition to the result mainly sought"—have since risen to the rank of main products. To-day, petroleum by-products are counted by the hundreds, and are increasing in number and in importance, and it seems quite likely that the romance of the coal-tar derivatives industry will, in the not-distant future, be paralleled by a great chemical industry having its basis in petroleum.

—*Abstract from "The American Journal of Pharmacy,"* 1923, XCV., 292-298.

LITERARY INTELLIGENCE.

An important new book entitled *Clouds and Smokes: the Properties of Disperse Systems in Gases*, will shortly be published by Messrs. J. & A. Churchill. The author is Dr. W. E. Gibbs, Chief Chemist to The Salt Union Ltd., Liverpool. There will be about 30 illustrations.

The investigation of matter in a highly

dispersed or "colloidal" condition has been largely directed towards those disperse systems in which the dispersion medium is a liquid or a solid. Less research has been made in fog, smoke, flame, cloud and the atmosphere itself. They are disperse systems in which a liquid or a solid substance exists in a highly dispersed, or colloidal, condition in a gas.

The author describes the various ways in which such disperse systems in gases can be formed, and deals fully with their mechanical, thermal, optical and electrical properties, and the conditions which determine their stability. This information is then applied to the practical problems of meteorology, fume condensation, gas filtration, the manufacture of substances in a finely powdered condition, and the use of smoke in warfare.

NITROGEN AND OTHER SUBSTANCES IN RAIN AND SNOW.

By John H. Woehlk.

It seems important to gain a knowledge of the various substances that come down in the rains and snows on account of the agricultural and hygienic significance. Similar work has been carried on for some time in the chemical laboratories of Cornell College, and in many other places.

Our special purpose is to determine the amounts of nitrogen compounds, chlorine and sulphates in the rains and snows of this locality.

The work was carried on under ordinary laboratory conditions. There is included a period of eight months, October 1, 1922, to June 1, 1923. The samples were collected in two granite pans, each 20 inches in diameter. The place is an open space near the centre of Mount Vernon, Iowa, which, including the college, has a population of about 2,500, without manufacturing enterprises. This condition eliminates excessive smoke contamination of the atmosphere. In the work every possible precaution was taken to avoid contamination. The samples were always collected soon after the precipitation, and the determinations were made as soon thereafter as possible.

Altogether forty-one samples were analysed, of which twelve were snow and twenty-nine were rain. There were 70 inches of snow and 11.2 inches of rain. This represents 17.21 inches of rain considering twelve inches of snow the equivalent of one inch of rain.

We found in the aggregate of the precipitations 20.35 pounds of chlorine, 0.57 pounds of sulphate as SO_3, and 3.93 pounds of nitrogen per acre. Phosphates were sometimes found, but only as a trace, never in sufficient quantity to be determined.

Expressed in parts per million, the chlorine varies from 3.54 to 28.1. The precipitations in this section, both the rain and snow, seem to come from the east, and the salt particles doubtless come from the Atlantic Ocean. The spray on the shore may be caught by the wind and is borne across the continent, until it descends, in solution in the precipitations. The chlorine was determined with hundredth normal silver nitrate, using neutral potassium chromate as the indicator.

The total nitrogen shows an average of 0.896 parts per million, and is quite constant. Electrical storms seem to have been responsible for some of the higher averages.

The average parts per million of free ammonia is 0.34, albuminoid ammonia 0.264, nitrogen in nitrates 0.346 and in nitrites 0.397, and sulphates, SO_3, 0.147.

The amount of the precipitation determines largely the number of pounds of nitrogen supplied per acre; but an examination of the pounds of nitrogen supplied by each of the 41 precipitations reveals quite a variation. This is due to the difference in the amount of rainfall, namely, 0.05 of an inch to 1.8 inches, and it shows a marked degree of concentration in the smaller precipitation. The same standard reveals the fact that during continuous precipitation, such as occurred from November 5-27, the total nitrogen gradually diminished.

We determined the various substances in each precipitation on the basis that one inch of rain on an acre weighs 226,875 pounds.

We desire to express our thanks to Dr. N. Knight for aid and encouragement in carrying on this work.

Cornell College,
Mount Vernon, Iowa.
June 27, 1923.

THE PROSPECTS OF A REVIVAL IN TRADE.

I think the President of the F.B.I., addressing the members in Bradford at the present time, could hardly choose any subject for his address other than the condition of trade and its prospects.

Twofold Meaning of "Trade Expansion."

An examination of the trade figures of the country over the past century, shows

two main features. Firstly, that trade moved in cycles of from 5 to 10 years; and, secondly, that trade as a whole moved steadily upwards, that is to say, that the lowest points and the peaks of the cycles of trade consistently showed a general upward tendency. The years of war upset both the regularity of the cycles and the regularity of their upward progression. At the present time, so far as I can see, in spite of the handicaps which the aftermath of war has left us, we are emerging from the bottom of a cycle, and even in spite of those handicaps I think that a mild form of optimism is possibly justified. It is difficult to account for the cycles in trade, but probably the principal reason is this. Finished goods take some time to produce, and the manufacturer looking ahead has to prophesy as to the results of his sales. As a rule a Sales Department is a little optimistic—if they were not they would not be a good Sales Department—and the manufacturing power of the country, anticipating the demand several months hence, tends to over-produce; that is to say, to produce more in prospect than the realised consumption. Free and unemployed money is used to finance this manufacture, and a point is reached when the over-production begins to show, and money becomes dearer because there is a shortage of money out of employment. Then the trade slump begins; prices break on account of over-production; manufacturers cut down their mill specifications; bankers, short of free cash, raise their credit rates; lack of confidence creeps in, and the trade depression is established. Consumption overtakes production, dear money means liquidation of stocks, and trade only begins to improve when, owing to conservative production, consumption has again exceeded it.

HOW TO PREVENT CYCLICAL FLUCTUATIONS OF TRADE.

It is difficult for anyone to dogmatise in these matters, but I hold the view that the cyclical depressions and heights of trade are really the outcome of the psychology of the manufacturer and the banker, but principally of the manufacturer. Without optimism and hope, this world would be a poor place, and we would effect little, but, as I see it, the principal cause of the cyclical fluctuations in trade—which are very undesirable—are caused by lack of accurate knowledge as to what the world can consume. It would be idealistic to hope that in this imperfect and competitive world we could estimate exactly what we could sell partitioning the demands among the various producers, but I feel sure much can be done by the collation and collection of information by the great trade and industrial organisations, to enable their members to forecast more accurately what the demand will be, and what production will be. In this, I think, the great nation of the United States of America is probably ahead of us.

NOTICES OF BOOKS.

Über Naturprodukte, Festschrift zum 70 Geburtstage MAX HÖNIG, Herausgegeben von PROF. DR. B. M. MARGOSCHES und PRIV. DOZ. DR. W. FUCHS. Pp. X. + 181, with 7 figures and a portrait. Dresden and Leipzig: Verlag von Theodor Steinkopff. 1923. Price 4s. 4d. unbound.

The recent celebrations of the Jubilee of Prof. Max Hönig by his colleagues, friends and students of the German Technical Institute at Brunn (Brno) have led the promoters to publish this collection of papers by various authors under the title of a chemical treatise on the knowledge and valuation of different natural products.

This Jubilee volume includes the contributions communicated on the occasion of the celebrations. Many were naturally from Hönig's students either still working at the Deutsche Technische Hochschule, Brunn, or in other countries.

Mr. C. F. Cross, F.R.S., communicated the first paper, *On Cellulose with Reference to Systematic Chemistry and Natural Science*.

Drs. Fischer and Tropsch, of Mulheim, gave a contribution, *Comparative Distillation in vacuo of Cellulose, Lignin and hardened Wood*.

Prof. P. Klason, Stockholm, described *Synthetic Researches on the Lignin of Pinewood*; Prof. E. Hägglund, *Lignin Hydrochlorides*; Dr. K. Kürschner, *The Pentosan Content of Pine Lignin*; Dr. B. Elsner, *The Methylation of Natural Products*; P. Ehrenstein, *Hönig's Extract as used in Tanning*; Prof. E. Jalowetz, Vienna, *The Baking-Power of an old Wheat Flour*; F. Tempus, *The Quantitative Estimation of Starch*; Prof. Margosches and Dr. F. Steindler, *On the Hindering of Reduction by Reducing Sugars caused by Trichloracetic Acid*; Dr. O. Wohryzek, *Raw-Sugar Refining*; Prof. E. Zerner, Vienna, *The Oxidation of Stearic and other Acids with Oxygen*; Prof. J. Marcusson, Berlin, *The Hönig-Spitz Procedure for separating Saponifiable and Unsaponifiable Oils*; Dr.

W. Fuchs, *The Humic Acid Problem;* P. Stamberger, Budapest, *Synthetic Humic Acids;* Prof. A. Lissner, *The de-sulphurising of Coke;* Prof. E. Donath, *Estimation of the Combustibles in the Firing-residues of Coals;* H. Rath, *The Hönig-Spitz Estimation of Boric Acid;* Dr. A. Kurtenacker, *Estimation of Bismuth in Ores and Industrial Products;* F. Abt, *The Purification of the Water of Brünn;* Prof. G. Ullrich, *The Water conditions in the Textile Industries of Brünn;* O. Kyas, *The Technique of Manuring Experiments;* Prof. C. Frenzel and Dr. E. Klarmann, *Röntgen Rays and their Application in Chemistry and Technology.*

The volume will appeal especially to those who have been connected, in some way, with Prof. Hönig or his work.

BOOKS RECEIVED.

Supplementary Notes on Gravimetric Analysis for Beginners, by W. Lowson, B.Sc., F.I.C. Pp. 54. 1923. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 2s. 6d.

Summary Report of Investigations made by the Mines Branch during the Calendar Year ending December 31, 1921. Pp. 346. 1923.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

15634—Chemische Fabrik vorm-Sandoz.—Manufacture of cardiac glucoside of bulbus scillæ. June 15.

15645—Perceira, H.—Process for manufacturing perylene vat-dyes. June 15.

15644—Perceira, H.—Process of manufacturing aminoperylenequinones. June 15.

Specifications Published this Week.

198385—Nielson, H., and Laing, B.—Manufacture and utilisation of formic acid.

198423—Wild, R., and Wild, A. H.—Manufacture of ferro alloys, particularly ferro-chromium alloys.

198545—Hechenbleikner, U., and Oliver, T.C.—Treatment of acids.

198576—Elektrizitatwerk Lonza.—Manufacture or preparation of metaldehyde.

198615—Chemische Werke Altstetten Akt-Ges.—Process for the manufacture of 1-phenyl-2-3-dimethyl-4-dimethylamino-5-pyrazolone.

Abstract Published last Week.

196072—2;4-Diamidophenol; photographic developers.—King, O., of 35, Russell Road, Kensington, London.

A compound of 2:4-diamidophenol with tin chloride, of good keeping qualities and suitable for use as a photographic developer, is prepared by treating 2:4-dinitrophenol with sufficient tin and hydrochloric acid or by boiling 2:4-diamidophenol with stannous chloride and hydrochloric acid, and precipitating with concentrated hydrochloric acid; the product may further be dissolved in water, sulphur dioxide passed in, and a product containing sulphur dioxide in addition to the tin chloride obtained.

Abstract Published this Week.

196431—Organic-mercury compounds. — Wolvekamp, M. E., of 1116, 2nd Avenue, Oakland, California, U.S.A.

Mercury derivatives of aurintricarboxylic acid and alkali salts thereof are obtained by heating with mercury compounds a solution of an alkali salt of the acid, or a suspension of the acid in a solution of sodium chloride. The products, which may contain one, two, or three atoms of mercury in the molecule, are substitutes for mercury salicylate; the free acids are insoluble in water, but soluble in sodium chloride solution. According to examples, products containing sodium chloride are prepared by boiling aurintricarboxylic acid ith sodium bicarbonate, mercuric chloride and water, filtering, and evaporating; products not containing sodium chloride are obtained by replacing the mercuric chloride by mercuric oxide, the mercuric aurintricarboxylates being precipitated by acidifying with sulphuric acid.

Messrs. Rayner & Co. will obtain printed copies of the published specification and abstract only, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,

VOL. CXXVII. No. 3301.

NOTE ON THE CHEMISTRY OF HAFNIUM.

By G. Hevesy.

The near relation between the chemical properties of hafnium and zirconium is clearly exhibited by the fact that all zirconium minerals contain hafnium, in an amount varying between 1 to 30 per cent. of their zirconium content. The relationship between hafnium and its higher homologue, thorium, on the other hand, is much less conspicuous. The most typical thorium minerals, such as orangite, thorite, and thorianite, were found to be free from hafnium.

The above conclusions, drawn from geochemical data, were fully confirmed by comparing the chemical properties of the principal zirconium and hafnium compounds. This investigation included compounds with hydrochloric, hydrofluoric, nitric, sulphuric, oxalic, carbonic, phosphoric and salicyclic acids, etc. Attempts to achieve a separation of hafnium from zirconium, based on the different solubility of the corresponding compounds, showed that the most successful method of separation was by the crystallisation of the potassium double fluoride. This compound can, as is well known, easily he prepared by melting the zirconium mineral with potassium hydrogen fluoride. The zirconium and hafnium double fluoride is then extracted with the aid of boiling water, which dissolves as much as 25 per cent. of K_2ZrF_6. When cooling down the solution the greatest part of the salt crystallises out, the solubility at 20° amounting only to 1.85 per cent. (in one-eighth normal hydrofluoric acid solution). The solubility of the hafnium double fluoride (amounting to about 3 per cent.) being larger than the solubility of the corresponding zirconium compound, the hafnium concentrates in the mother-liquor. The efficiency of this method is shown by the following data:—

1000 grams of K_2ZrF_6, containing 6 per cent. of K_2HfF_6, were crystallised from a 10 per cent. HF solution. After repeating this operation four times the remaining 750 grams of the double fluoride contained only 2 per cent. K_2HfF_6, and the hafnium concentration of the mother liquor was correspondingly raised.

The above-mentioned method of separation can also be replaced by a crystallisation of the corresponding ammonium compound or successfully combined with the partial precipitation of zirconium hafnium compounds with ammonia, or by boiling the solution with sodium thiosulphate, and so on. Hafnium being more basic than zirconium, the first precipitate accordingly contains relatively less, the last relatively more hafnium than the original material.

The phosphate of hafnium, on the other hand, was found to be appreciably less soluble in concentrated acids than the phosphate of zirconium, but this method of separation was rather tedious considering the difficulties attending the resolution of the phosphate. A partial separation was further achieved by distilling the tetrachloride at about 250° C., but this method also was found much less successful than the crystallisation of the double fluoride. The hafnium content was in all cases Röntgen-spectroscopically determined. A detailed description of this method by Dr. Coster will be given in a subsequent issue of *The Chemical News*.

By using the above described method of separation, large amounts of hafnium still containing 5 to 6 per cent. of zirconium were obtained. A preliminary atomic weight determination, carried out with the aid of this material, gave a value for the atomic weight of hafnium lying between 178.4 and 180.2. (Concerning further details of this determination, see the July, 1923, issue of the *Ber. d. deutsch. Chem. Ges.*)

The properties of K_2ZrF_6 and a large number of other double fluorides were investigated in detail by the French chemist, Marignac, and described in a most fascinating contribution to the *Annales de Chimie et de Physique* in 1860. He purified his zirconium by crystallising the K_2ZrF_6 and calculated the atomic weight of zirconium from the ratio $\frac{K_2ZrF_6}{ZrO_2}$

It is of interest to note that Marignac, to prove the homogenity of the element zirconium doubted by Svanberg and others, determined the solubility of different K_2ZrF_6 fractions. No difference was found. Marignac prepared his double fluoride from a nearly colourless zircon, "presumably" from Ceylon, which was found by us to have a rather low hafnium content. The

accuracy of Marignac's solubility measurements amounted to about 1 per cent., which was not sufficient to detect the presence of hafnium in his material with the help of solubility measurements.

Copenhagen, Universitetets Institut for Teoretisk Fysik.
June, 1923.

THE COLORATIONS OF CERTAIN QUARTZ AND THEIR MUTABILITY

By Georg O. Wild and R. E. Liesegang.

To the older observations on the changes of colour produced by the influence of Heat, Light, and Rontgen-rays, Doelter has recently added others. Still more may be noted.

Many reddish amethysts become colourless when heated to 500-600° C. On cooling, a yellow colour suddenly develops at about 275° C.

These stones are colourless, light yellow, light violet, brownish violet, or reddish brown. Some may be colourless with amethyst coloured seams running across. All these varieties became yellow at 500-600° C. Below this the light violet stones became brownish or reddish yellow. The others changed slightly at temperatures below 500° C., the colourless ones remained partly colourless. Many of these ambers appear exactly similar to the yellow quartz of Brazil and Madagascar. In fact, the latter became colourless when heated.

An improvement of the colour shades of amethysts by the application of short or long-waved Rontgen rays has now been attempted by us.

From the work of Doelter, the hypothesis that the change of colour, which certain characteristic minerals exhibit under the action of light, Rontgen, and the different radium rays, arises from the changing of the degree of dispersion of the admixed colouring bodies.

Doubtless, such changes in the degree of dispersion make big changes in the colour. *One o us, e.g.,* has shown that the same *amount of metallic silver in a layer of gelatine can be so dispersed that this layer becomes colourless and transparent like glass or the layer becomes absolutely opaque.*

Between these two extremes are all stages from light yellow, orange deep red, brown, olive green; very deep blue are also appear by transmitted light. From the colourless, through the yellow to the black, the size of the silver particles increases, and yet it is to be admitted that *it is difficult for us to abandon Doelter's views. The colloid particles of the colouring matter can undergo coagulation in the solid crystal lattice, or in a crystal aggregate a kind of coagulation (or peptisation).*

This is comparable with Zsigmondy's experiments, in which red gold sols turn to blue when electrolytes are introduced.

It is also comparable with the gel formation in aqueous albumin and cerium oxide sols under the influence of Radium Rays, as was studied by A. Fernau and W. Pauli. In the latter case, the tendency to coagulate is not hindered by the presence of protective colloids, gel-media, or by the crystal lattice structure of the body.

On the other hand, Marc's results from studies of effect of traces of special organic dyestuffs in preventing actual crystal lattice formation, point in another direction. The movement of colloid particles has been *shown not to occur in gels* which are not quite set, how then can the coagulation be hindered inside a solid crystal? The colloid particles, then, must be regarded as not movable.

The coagulation theory completely fails to explain this.

There are other possibilities which admit of the change of degree of dispersion in a rigid system, namely, in the case where intermediate solution comes in. For instance, silver chloride should be very finely dispersed in a gelatin gel, so that the cloudiness is very small.

When sodium nitrate diffuses with this gel a great increase of the cloudiness occurs. A part of the silver chloride has dissolved to form an intermediate solution.

The other particles of the silver chloride then increase in size from this solution. This may well occur in minerals.

The Röntgen Rays make amethyst darker but the heating makes it lighter again. Diffusion would take a long time in this medium, and the changes by heating are too quick for this. Our ultra-microscopic experiments with heated and unheated amethyst have not shown any support fr- the theory of the change of dispersion. Th purely chemical hypothesis seem to off the most satisfactory explanation.

(From the Centralblatt f. Min., 1923 XVI, 491.)

EMPIRE COTTON AND RESEARCH.

£5,000 Donation to Imperial College.

The Empire Cotton Growing Corporation has recently been considering the necessity for organised research at the Universities and Colleges of Great Britain, and has decided to offer retaining grants to certain Universities where highly specialised research is already going on. The Cotton Corporation has offered to the Imperial College of Science and Technology, South Kensington, the sum of £1,000 a year for a period of five years from October 1, 1923, the money to be devoted to Plant Physiology and Plant Pathology in the Department of Botany. This generous offer has, we understand, been accepted by the Governing Body, and the research work will be undertaken in the new Botany Building which was recently opened by the Duke of Devonshire, and to which the Rubber Growers' Association of the City of London subscribed approximately £30,000 about two years ago. This donation is tangible evidence of the value which tropical agriculturists attach to the important research work which is being undertaken at the Imperial College, especially in connection with plant physiology and pathology under the direction of Professor J. B. Farmer, F.R.S., and Professor V. H. Blackman, F.R.S. We have no doubt that other groups interested in research work will continue to support undertakings of this character.

The United States Department of Agriculture has issued a Department Bulletin, No. 1147, entitled *Chemical, Physical, and Insecticidal Properties of Arsenicals*, by F. C. Cook and N. E. McIndoo.

This study of the chemical, physical, and insecticidal properties of arsenicals on the market was undertaken in order to gain a better understanding of them, to be able, if possible, to improve them, and to produce new arsenicals for insecticidal purposes. The results of this investigation, which was conducted by the Bureau of Chemistry and the Bureau of Entomology of the United States Department of Agriculture, are here reported.

Paris green and lead arsenate, which have been standardised and found reliable for many years, have constituted the principal insecticides used against external chewing insects. However, during the past few years, the use of calcium arsenate has steadily increased, owing in part to the discovery that it is effective in combating the boll weevil. The manufacture of calcium arsenate, although well beyond the experimental stage in most factories, probably will not be completely standardised for several years. Because of the importance and recent large-scale production of calcium arsenate, many of the results in this bulletin deal with comparisons of calcium arsenate and acid lead arsenate.

Chemical Properties of Arsenicals.

Arsenious oxide (As_2O_3), commonly called white arsenic or simply arsenic, is the basis for the manufacture of all arsenicals. Arsenious oxide is a by-product from the smelting of lead, copper, silver, and gold ores, being recovered from the flue dust and fumes. The arsenious oxide first sublimed is impure, owing to the presence of carbon and sometimes of sand. The impure oxide may then be resublimed to give a relatively pure one, consisting of approximately 99 per cent. of arsenious oxide and a trace of arsenic oxide (As_2O_5). Between 11,000 and 12,000 tons of arsenious oxide were produced in the United States in 1920, more than half of which was used for insecticide purposes. Canada, Mexico, England, Germany, France, Japan, and Portugal produce large quantities of arsenious oxide.

There are three forms of arsenious oxide: (*a*) The amorphous, vitreous, or glassy form; (*b*) the ordinary crystalline ("octahedral") form; and (*c*) the orthorhombic crystalline form. The amorphous form changes spontaneously into the crystallin form on standing. The trade usually recognises two grades, the light and the heav forms, although they are the same chemically.

The literature contains conflicting statements concerning the solubility of arseniou oxide in water. Because of the slownes with which it goes into solution, man weeks being required to dissolve even small sample of the solid, it is probab that in all of the reported results equi brium had not been reached. The varyi percentages of crystalline and amorpho material present in the samples tested, t amorphous form being more soluble th the crystalline forms, may possibly help account for these discrepancies.

With the exception of Paris green, arsenites are prepared by combining arse ous oxide and the base.

As a rule, arsenates are made by direct action of arsenic acid in solution o metallic oxide. The arsenic acid used

this purpose is manufactured from arsenious oxide by oxidation, usually by means of nitric acid.

BASES USED IN PREPARING ARSENICALS.

The oxides of lead, zinc, calcium, and magnesium are the bases most used in manufacturing arsenicals. Litharge is the commercial calcium oxide. Zinc oxide (ZnO) and lead oxide (PbO), ordinarily employed in the manufacture of zinc arsenite and lead arsenate, are more expensive than calcium oxide (CaO) and magnesium oxide (MgO) used in manufacturing calcium arsenate and magnesium arsenate.

The principal lead arsenate is acid lead arsenate ($PbHAsO_4$), an acid salt, so-called because of the presence of hydrogen (H) in its molecule. It has the following theoretical composition, As_2O_5 (33.13 per cent.), PbO (64.29 per cent.), and water of constitution (2.58 per cent.).

In the early procedure for preparing acid lead arsenate, solutions of lead acetate or of lead nitrate were precipitated by sodium hydrogen arsenate (Na_2HAsO_4). The tendency is to produce acid lead arsenate when lead nitrate is used, and the more basic form when the acetate is used. McDonnell and Smith obtained acid lead arsenate of practically theoretical composition by precipitating lead nitrate or lead acetate by an excess of monopotassium arsenate. A method frequently employed in manufacturing this arsenate is to mix arsenic acid (H_3AsO_4) and litharge (PbO) in the presence of a small amount of nitric acid. The fact that acid lead arsenate is a comparatively stable compound and is but slightly soluble in water, offers an explanation as to why it burns foliage only very slightly when properly applied.

BASIC LEAD ARSENATE.

The early investigators recognised "basic," or "sub," arsenate of lead, and applied the term "neutral lead arsenate" to $PbHAsO_4$, which is the present commercial acid lead arsenate. They also applied the term "neutral lead arsenates" to lead pyroarsenates, which are not commercial products, and therefore will not be discussed here.

Basic lead arsenate may be prepared as follows: Produce basic lead acetate by the action of acetic acid on lead or lead oxide, usually litharge. Then mix it with arsenic or d, thus forming basic lead arsenate.

B.. lead arsenate may also be made by stages ..ion of sodium arsenate, litharge, brown, oli.. and nitric acid, or by the action of ammonia on acid lead arsenate. It has the following theoretical composition: As_2O_5 (23.2 per cent.), PbO (75 per cent.), and water of constitution and crystallisation (1.8 per cent.). The specific gravity of this substance was found by McDonnell and Smith to be 6.86.

CALCIUM ARSENATES.

Pickering, in 1907, stated that calcium arsenate had already been used in the United States as an insecticide. He gave the proportions of a calcium salt and an arsenate to be united in preparing calcium arsenate, recommending the use of an excess of lime in order to produce a calcium arsenate with all the arsenic precipitated and therefore containing no appreciable amount of water-soluble arsenic.

As many of the early commercial samples of calcium arsenate contained excessive amounts of water-soluble arsenic, frequent scorching of foliage resulted from its use, thus retarding its general introduction. Since 1907, many experiments to devise a method for making a commercial calcium arsenate have been performed. It is now being produced by many American manufacturers, and its sale is constantly increasing. The quality of the commercial product has been much improved during the past few years, but its course of manufacture has not yet been standardised as has that of lead arsenate.

Dicalcium arsenate ($CaHAsO_4(H_2O)$) contains theoretically 28.3 per cent. of calcium oxide and 58 per cent. of arsenic oxide. It breaks down easily in water, yielding a large quantity of water-soluble arsenic, and is not suitable for commercial spraying purposes.

The following simple method of preparing calcium arsenate commercially, as outlined by Haywood and Smith, calls for the direct mixing of calcium hydroxide and arsenic acid, the only by-product being water: Slake the lime to a smooth paste by using from 3 to 3½ times as much warm water (by weight) as lime, and allow it to stand until the lime is completely slaked. Then mix it, add the cold arsenic-acid solution at room temperature as rapidly as possible, and stir the mixture well until the liquid becomes alkaline to phenolphthalein. Lastly, filter, dry, and grind the resulting compound.

The lime and arsenic acid should be mixed in such proportion that the actual weight of calcium oxide used will be equiva-

lent to that of the arsenic oxide employed. This method produces a reasonably light (bulky) material, which is easily pulverised. The finished product should contain approximately 44 per cent. of calcium oxide, from 40 to 42 per cent. of arsenic oxide, and from 14 to 16 per cent. of water and impurities, which approaches the ratio, 4 CaO : 1 As_2O_5. The excess of lime is used to keep any soluble calcium arsenate from remaining in the product.

Paris Green.

Paris green, originally used as a paint pigment, is said to have first served as an insecticide in the western United States. It is a compound of arsenic, acetic acid, and copper, known as aceto-arsenite of copper. The theoretical composition of Paris green is copper oxide (31.39 per cent.), arsenious oxide (58.55 per cent.), and acetic anhydride (10.06 per cent.)

The manufacture of Paris green, which has become standardised, may be briefly described thus: Solutions of sodium carbonate and arsenious oxide are heated together, forming sodium arsenite. Crystalline copper sulphate is dissolved in warm water in a separate container. The sodium arsenite mixture is poured into a mixing tank, the copper sulphate solution is added, and the mixture is stirred. Acetic acid is added, and after a little stirring the olive-coloured mixture becomes green. The Paris green is washed with water, after which it is allowed to settle, and all the water that can be drained off is so removed. This washing should be repeated as often as necessary to remove practically all the sodium sulphate. The Paris green is then dried. The dried product is passed through a "breaker," and finally through a fine sieve or a bolting machine. The "tailings" are mixed with the next batch of Paris green. The finely divided Paris green is now ready to be placed in containers.

The conclusions that may be drawn from this investigation are that a chemical analysis of an arsenical does not give sufficient data to judge satisfactorily its insecticidal properties, and a toxicity study alone does not show that an arsenical is suitable for general insecticidal purposes, but both a chemical analysis and a thorough toxicity study are required in order to judge whether or not an arsenical is a satisfactory insecticide.

GENERAL NOTES.

TRADE CATALOGUES REQUIRED IN NICARAGUA.

Mr. T. J. Rees, H.M. Consul at Managua, has informed the Department of Overseas Trade that although the supply of catalogues and price lists available at the Consulate is very limited, he has, nevertheless, been able to divert orders to the United Kingdom through their use. Similar conditions obtain at Leon and Granada.

The Consul suggests, therefore, that there are good prospects of increasing British trade by supplying him, and the Consular Officers at Leon and Granada, with catalogues and price lists of manufacturers of the following (among others):—

Novelties, cutlery, ironmongery, pottery and glassware, stationery, fine and pharmaceutical chemicals, patent medicines, druggists' sundries, toys, firearms, and of any other articles in general demand.

Further, should samples be supplied, the Consul would be pleased to use them to the best possible advantage.

Firms desiring to take advantage of the possibilities offered, should forward three copies (for use at the three ports named) of their catalogues, etc., directly to His Majesty's Consul, British Consulate, Managua, Nicaragua.

GERMANY'S TRADE AND INDUSTRY IN JUNE.

Mr. J. W. F. Thelwall, Commercial Secretary at Berlin, has forwarded to the Department of Overseas Trade a review of Germany's trade and industry during June. From the report it is seen that the month was noteworthy for a further extraordinary depreciation of the mark. On the one hand this led to a strong revival of trade, with the result that an improvement occurred in many branches of industry, *e.g.*, in the textile, leather, paper, india-rubber and glass industries. The potash, machinery, and chemical industries were also able to record better sales. On the other hand, the currency depreciation led to quite exceptional advances in prices. The wage increases in the first half of June, to 55-60 per cent. as compared with May, and in the second half of June to about 60 per cent. as compared with the first half of the month. The market conditions in occupied territory continued to develop unfavourably. The pressure of occupation became increasingly

greater. The deliveries of coal and coke did not increase in quantity, while, as regards quality, they became still worse. Coke was produced only to meet the immediate requirements of the foundries and gasworks. The coal supplies also diminished constantly. The time is not far distant, therefore, when deliveries will have to cease.

Potash. — The general situation in the potash industry was favourable. Sales, which had declined heavily in March and April, revived in May under strong calls from home and abroad. These calls continued throughout June. As a result, shifts which had previously been dropped were resumed, so that the works in June were, in general, fully employed. The fuel supply was adequate. The quality of the coal delivered left, however, much to be desired.

Chemical Industry.

The strong home demand was maintained owing to the heavy currency depreciation which occurred in the course of the month, and it was not always possible to carry out orders promptly. The raw material supply from abroad proceeded without interruption or difficulty.

Paper Industry.

Owing to the depreciation of the mark, the prices of paper wood rose considerably. The small quantities still available on the inland market from the last fellings fetched prices two to three times higher than those in the previous month. Inland sales increased somewhat and foreign trade continued very brisk. Production equalled that in the preceding month. The labour supply was adequate. In the paper wholesale trade the demand continued satisfactory, and the factories were again better employed.

India-Rubber Industry.

The india-rubber industry was probably everywhere very actively employed, as the home demand was very lively. A considerable clearance of the accumulated stocks was, in part, effected. Price increases were not nearly able to follow the movement of foreign exchanges. The fuel supply still caused the gravest anxiety.

BOARD OF TRADE ANNOUNCEMENT.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.
APPLICATIONS FOR LICENCES IN JUNE.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during June, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 512, of which 393 were from merchants and dealers. To these should be added the 21 cases outstanding on June 1, making a total for the month of 533. These were dealt with as follows:—

Granted—372 (of which 328 were dealt with within seven days of receipt).

Referred to British makers of similar products—96 (of which 78 were dealt with within seven days of receipt).

Referred to Reparation supplies available—41 (all dealt with within two days of receipt).

Outstanding on June 30—24.

Of the total of 533 applications, 436, or 80 per cent., were dealt with within four days of receipt.

Board of Trade.
July 11, 1923.

CHEMICALS REQUIRED IN U.S.

Mr. L. E. Bernays, H.M. Consul at New York, reports that a local firm are desirous of purchasing the undermentioned chemicals in England, primarily for sale in Cuba:

Ref. Pyridine.

Ammonium Carbonate, Lump and Powdered.

Castor oil of the No. 1 or medicinal grade.

Whiting (Blanco Espana).

Tartaric and Citric Acid.

Naphthalene flakes and balls.

British firms desirous of receiving further particulars regarding this enquiry should apply to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1, quoting reference 20039/F.W./C.C.2.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE FARADAY SOCIETY.

A GENERAL DISCUSSION ON "THE ELECTRONIC THEORY OF VALENCY" HELD AT CAMBRIDGE ON JULY 13-14, 1923.

Valency and the Electrons, by GILBERT N. LEWIS.

As it is the purpose of this discussion to secure a better understanding of divergent points of view, I have chosen a few questions which seem likely to arise and which concern the application of the newer theories of valence to the problems of chemistry. I should like to express my belief that the two views of the structure of the atom, derived respectively from chemical and physical researches which a few years ago seemed so incompatible, are now reconcilable.

While Bohr, in his development of quantum theory, has accounted for the general characteristics of the periodic table by assuming groups of energy levels, of which the first may contain two, the second eight, the third eighteen, the fourth thirty-two electrons, etc., there is nothing to show why the group of two electrons and that of eight play so important a role in the outer shells. Thus the rare gases from neon to niton possess eight electrons in the outer shell, the same is true for all stable elementary ions such as K^+, Al^{+++}, S^{--}.

Prof. Lewis went on to discuss the electron pair as the chemical bond, nomenclature, multiple bonds, conjugation and polarisation.

Bohr's Atom in Relation to the Problem of Covalency, by R. H. FOWLER, M.A.

Considerable advances have been made in our views on atomic structure since the idea of nuclear structure was put forward by Rutherford in 1911. From Bohr's work the main features now seem to have been worked out.

Prof. Fowler considered the physical interpretation of covalence from a study of the hydrides of boron, sulphur hexafluoride, and the co-ordinated compounds of cobalt.

The Nature of the Non-Polar Link, by N. V. SIDGWICK.

No theory of the physical nature of valency can take us very far unless founded on some definite conception of atomic structure. In the remarks that follow I have assumed the truth of Bohr's theory of the atom, based on the application of dynamics (under the quantum restriction) to electrons which are held in their orbits by the balance between their mutual electrostatic repulsions and the attraction of the nucleus, and centrifugal force.

It is generally admitted that the non-polar (as opposed to the polar) link consists in the "sharing" of two electrons between the two linked atoms. The only new assumption which I make is that the orbit of each "shared" electron includes both of the attached nuclei. This assumption has been found by Professor Nicholson to be the only one which will account for the spectrum of molecular hydrogen; and it has also been put forward by Dr. N. P. Campbell as a more or less self-evident extension of Bohr's theory to non-polar linkages. The author considered the results obtained by applying this conception to chemical facts.

There are two obvious differences between such binuclear orbits and the simple orbits of Bohr. One is that the presence of a second nucleus in the orbit makes precession of the orbit impossible, unless indeed the same orbit successively includes several nuclei. The second is that all the electrons shared by any one atom have to pass through their perinuclea in due succession, and hence their periods must agree; moreover in a chain of atoms the periods of all the binuclear orbits must be the same, or must differ rationally.

The theory explains why the groups attached, say, to a carbon atom retain their relative positions, in spite of the fact that each of the electrons holding them goes round the carbon nucleus; and these positions may be expected to have the tetrahedral symmetry which Bohr finds in the 4 orbits of an electron sub-group.

It also satisfies the condition of permitting the free rotation of singly linked carbon atoms.

Co-ordination.

What Werner calls the *co-ordination* number of an atom is the number of non-polar links that it is able to form. This is proved by the occurrence of optical activity among the 6-co-ordinated compounds under conditions parallel to those which hold among asymmetric carbon compounds. Werner's substances can be formulated without assuming any kind of valency other than polar and non-polar linkages, if we realise that while a monovalent group (like $-Cl$ or $-NO_2$) contributes one electronic orbit to the central atom, a group which can exist as an independent molecule (such as ammonia or water) contributes two, the nitrogen or oxygen assuming a higher valency by the loss of an electron, or, if you will, supplying both electrons for the link. If the resulting complex is an ion, its electrovalency must be added or subtracted. Thus you get a value for the number of or-

bits added to the atom in the compound, and by adding this to the atomic number you arrive at what may be called the effective atomic number.

The Electronic Theory of Valency. Part II.—Intramolecular Ionisation in Organic Compounds, by PROFESSOR T. MARTIN LOWRY, C.B.E., M.A., D.Sc., F.R.S.

1.—*Intramolecular Ionisation in Inorganic Compounds.*

In the *preceding paper* of this series I directed attention to the fact that the electronic theory of valency permits of a very wide extension of Thomson's theory of intramolecular ionisation, and that polar bonds may be detected in a large range of inorganic compounds where it has been generally assumed hitherto that the linkages are all of a non-polar or covalent type. In particular, a study of the electronic formulæ of Langmuir reveals the fact that, whilst there is usually a perfect balance between the nuclear charge of each atom and the enveloping shell of electrons, in other cases the negative charge of the shell is either too large or too small to balance exactly the positive charge of the nucleus.

2.—*Application to Organic Compounds.*

An extensive application of the theory of intramolecular ionisation to organic compounds is rendered possible by taking advantage of a more recent conception of Sir J. J. Thomson. He suggests that the reactivity of double bonds in organic chemistry may be attributed to the fact that it is easier to open the hinge between two cubical octets sharing a common face than to break the hnge which holds together two octets sharing only a common edge. This view can scarcely be accepted as an adequate explanation of the reactivity of double bonds, since fluorine is in fact far more reactive than oxygen; but if the assumption be made that the rupture of the double bond takes place unsymmetrically, so as to leave 2 L-electrons on one atom and only 6 on the other, a very suggestive system of formulæ is arrived at, in which ethylene is represenctd as containing a "mixed double bond." whilst acetylene can be represented in a similar way as containing a "mixed triple bond."

The theory of intramolecular ionisation can thus be extended to organic compounds, if it be assumed that double bonds assume a form in which *one* carbon carries *eight* L-electrons, but the *other six*, one pair of electrons only [illegible]. Since the former atom is then negatively and the latter positively charged, this type of double bond may be represented as made up of one co-valency and one electrovalency.

This extension of the theory of intramolecular ionisation brings the reactivity of organic compounds into line with the well-recognised activity of inorganic ions, and makes it possible to regard *all* chemical action as ultimately ionic in character.

The resting forms of the molecules need not be identical with their ionised or reactive forms. Examples are given, however, of organic compounds which probably have a permanently-ionised structure, comparable with that of metallic salts. In other cases evidence is quoted to show that this condition results from a definite process of activation.

Attention is directed to several phenomena which receive a simple explanation in the "crossed polarities" of compounds which have hitherto been classed as "conjugated."

The properties of "multipolar ions" are referred to as furnishing a basis for a novel theory of tautomeric ions, and an explanation of their readiness to yield co-ordination-compounds.

Part III.—The Transmission of Chemical Affinity by Single Bonds.

It is shown that the reactivity of the methyl-group in ethyl crotonate is in harmony with the theory of polar double bonds. It cannot be used as a proof of the existence of polarised single bonds (polar co-valencies), since it receives a simple interpretation in terms of Thiele's theory of conjugation.

The small fluctuations which are observed in the strength of unsaturated acids as the double bond is moved along the chain may be attributed to steric influences such as those which Pickard has discovered in optically active compounds.

The fact that amino-acids are sometimes stronger than the acids from which they are derived is attributed to the acylous character of the amino-group; this is usually masked by the direct neutralising action of the basic group.

The conclusion is drawn that alternate polarities are characteristic of conjugated systems, and are not developed in chains of single bonds, where both acylous and basylous groups produce effects of constant sign.

Remarks on Some Recent Contributions to the Theory of Induced Alternate Polari-

ties in a Chain of Atoms, by ARTHUR LAPWORTH and ROBERT ROBINSON.

. . . .

The deductions of the Principle of Induced Alternate Polarities put forward by Lapworth and by Kermack and Robinson, though having little superficial resemblance in some respects, are, on critical examination, found to be identical in others, and suggest very similar applications of the rule. The range of phenomena embraced by the theories is very wide, but a complete exposition of the subject in relation to reactivity, orientation, mechanism of reactions, intramolecular rearrangements, tautomerism, co-ordination, triphenylmethyl, and physical properties of substances could only be attempted in a monograph, and such a work we are engaged in preparing for publication. In broad outline the principle may be said to have developed as a common expression of such well-known rules as those of Markownikoff, Michael, and Crum Brown; in particular, the regularities observed in the course of substitutions in aromatic compounds had a specially noteworthy importance in revealing the wider generalisation. It is therefore not a little surprising to find that some recent contributions to the subject reverse the order, and, employing the general theory as a basis, proceed to point out that certain groups of facts are in harmony with the principle. For example, Fraser and Humphries (*The Chemical News*, 1923, CXXVI., 257) find that the theories may be applied to the manifold problems of orientation in the benzene series.

Lowry's theory of mixed double bonds fails to suggest any explanation whatever of the most important facts which led to the recognition of the "Principle of Induced Alternate Polarities," a few of which facts have been mentioned above, and it is inadmissible as an explanation of the Principle, since it introduces theoretical limitations where no distinctions are in practice to be perceived. There are theoretical difficulties also. The remark that *a double bond in organic chemistry usually reacts as if it contained one co-valency and one electrovalency* is, with its double qualification, unexceptionable, being no more than a restatement of the fact that unsaturated compounds undergo polar additive reactions.

Octet Stability in Relation to Orientation and Reactivity in Carbon Compounds, by ROBERT ROBINSON.

The explanation of the alternating polar effect advanced by Kermack and Robinson has apparently been misunderstood in some quarters, and further remarks on the subject may not be out of place. Two deductions from the octet theory were made, and the second was an interpretation of the mechanism of addition to conjugated systems, a precise translation in electronic terms of earlier representations by means of partial valency symbolism. Here it was shown that the α-γ-rule is in part a consequence of the preservation of octets in the intermediate atoms of the chain, and the schemes given are fundamentally identical with some of the cases presented by Lapworth in a more general form. Some time before, the writer had suggested that the residual or additional partial valencies of Thiele should be replaced by real partial valencies, which in the sum are equivalent to the normal valency, and the interest of the translation in electronic terms partly resided in the fact that it was possible only when this real partial valency theory was adopted. So natural does this suggestion appear that in several recent text-books and memoirs the theory is ascribed to Thiele, although this author did not adopt a partial valency symbol derived by splitting a normal valency, and his benzene formula was not, as many writers now assume, more symmetrical than that of Kekulé.

In connection with the first deduction from the octet theory, which concerns what may be called static alternate polarity, misconception has arisen. The octet theory was employed in a more or less symbolic fashion, making no assumptions in regard to the position of electrons or the precise significance of covalency. The views advanced are considered to be just as sound on the basis of the Rutherford-Bohr atom as on the Lewis-Langmuir atom. The essential point is that there are certain stable electronic configurations associated with individual atoms and termed for convenience octets; although if they are duplets, sextets, decets, or dodecets the argument is unaffected. The second stage is that there must be some octet-stability factor which is not wholly the outcome of the equilibrium of electrostatic forces. It should be remarked that the words stable and unstable are used in reference to behaviour in the course of reactions.

THE SEPARATION AND DETERMINATION OF SODIUM AND LITHIUM BY PRECIPITATION FROM ALCOHOLIC PERCHLORATE SOLUTION.[1]

By H. H. Willard and G. Frederick Smith.

[Contribution from the Chemical Laboratories of the University of Michigan and the University of Illinois.]

A review of the literature on the separation of sodium and lithium shows that none of the methods so far suggested is entirely satisfactory. The solubility corrections are usually large and the separation must be repeated one or more times.

Most of the methods proposed involve the extraction of lithium chloride from the anyhdrous mixed chlorides of the metals involved, using an organic solvent or mixture of solvents in which the chlorides other than lithium chloride are insoluble. Another general type of procedure consists in dissolving the mixed chlorides in the least quantity of water necessary for their solution, followed by the precipitation of the chlorides other than lithium chloride, by the addition of an organic solvent or mixture of solvents in which the chlorides precipitated are but slightly soluble, a correction being applied for this slight solubility.

A full and critical discussion of the papers relating to this subject up to the year 1912 is given by Skinner and Collins.[2] Of the more recent work, that of Winkler[3] employs isobutyl alcohol in an extraction emthod, more than one extraction being required in each analysis. The method is tedious in operation and subject to errors, because of the number of manipulations involved. In the method of Palkin[4] a concentrated aqueous solution of the mixed chlorides is precipitated by the addition of anhydrous alcohol followed by ether. The chlorides thus precipitated are filtered and the small amount remaining in solution is recovered by evaporating to dryness and extracting with alcohol and ether. The method is an improvement over the others, since it eliminates the solubility correction, but the use of the volatile ether is a disadvantage.

The methods in which chlorides are precipitated rather than extracted most closely approximate the usual analytical processes and are theoretically more accurate. However, Palkin's process is, strictly speaking, not really such, as the precipitant does not carry a component which enters into the composition of the precipitate formed; moreover, the method is applied to saturated rather than dilute solutions.

The object of the present paper is the development of a method for the separation and determination of lithium and sodium, based upon precipitation of the material separated, in a manner analogous to the usual analytical practice.

The Method.

The process, in brief, consists in the precipitation and separation of sodium chloride from a solution of the mixed perchlorates of sodium and lithium in *n*-butyl alcohol by the addition of a butyl alcohol solution of hydrogen chloride according to the reaction, $NaClO_4 + HCl = NaCl + HClO_4$. The reagent is added to the solution of the perchlorates until a 6 per cent. acid concentration is attained. The precipitated sodium chloride is filtered on a weighed Gooch crucible, washed with a 6-7 per cent. solution of hydrogen chloride in butyl alcohol, dried at 250° and ignited for a few minutes at 600°. The lithium chloride, after removal of the organic matter by evaporation, is determined by conversion tc lithium sulphate, a correction being applied for the almost negligible amount of sodiurr chloride remaining in the filtrate. In somc cases the reagents give a slight blank. Potassium cannot be present since its perchlorate is insoluble in alcohol.

Preparation of Materials.

Normal Butyl Alcohol.—This material i readily obtainable on the market at th present time at a moderate price. Th alcohol used in this research had a boilin range of 112-118° and a density of 0.8065 a 25°/4°; 60 per cent. of this product boile within a range of 1° of the true boilir point. This fraction, when dried by reflux

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[1] *The work done in connection with this paper was suggested by H. H. Willard and th epreliminary work was carried out at the University of Michigan. The final work was done at the University of Illinois.*

[2] *Skinner and Collins, U.S. Dept. Agr., Bur. Chem. Bull.*, 1912, CLIII.

[3] *Winkler, Z., anal. Chem.*, 1913, LII., 628.

[4] *Palkin, Jour. Amer. Chem. Soc.*, 1916,

ing with a slight excess of metallic calcium, periments were also carried out using alco- had a boiling range of 116.2-116.7° and a density of 0.8060 at 25°/4°. Half of this fraction boiled within a range of 0.05°. In most of the work the 60 per cent. fraction, obtained as described above, was used. Ex- hol of widely different constants, the data concerning which will be recorded later.

Perchloric Acid.—The method of Willard[5] was used for the preparation of the perchloric acid. It was twice distilled under a pressure of from 5 to 15 mm. and contained about 72 per cent. $HClO_4$. Ten g. of this material when evaporated in a platinum crucible gave an almost unweighable residue after ignition.

Sodium Chloride.—An imported product of highest purity was used.

Sodium Perchlorate.—This material was prepared by treatment of the purest sodium carbonate with a slight excess of dil. perchloric acid. The anhydrous sodium perchlorate was obtained by crystallisation above 50°, using centrifugal drainage. The product thus obtained was dried in a current of dry air at a temperatrue of 250°. To obtain samples of sodium perchlorate for the analytical separations, pure sodium chloride in weighed portions was evaporated on a hot plate with a slight excess of perchloric acid until fumes of perchloric acid were no longer evolved.

Lithium Chloride.—This material was prepared from a product which contained some sodium chloride. It was freed from the latter by solution in hot butyl alcohol under a reflux condenser. The solution was cooled and the sodium chloride filtered off. The lithium chloride in the filtrate was recovered by evaporation in a platinum dish to a party mass which was dried in an electric oven at 100°. It was further heated in a muffle at 500°, and finally fused in a current of hydrogen chloride dried with sulphuric acid. The product thus obtained was cooled, crushed, and powdered under conditions which insured no contact with atmospheric moisture. It was used only in the solubility determinations.

Lithium Perchlorate.—The method employed in the preparation of this material was that described by Richards and Willard.[6] Lithium nitrate was purified by recrystallisation and then precipitated by the addition of hydrofluoric acid. The lithium fluoride was converted to perchlorate by evaporation with pure perchloric acid. This was then recrystallised from water with centrifugal drainage, platinum vessels being used throughout. The lithium perchlorate trihydrate thus obtained was dehydrated by fusion in a current of dry air at 250°.

Samples of this anhyrdous lithium perchlorate were weighed into platinum crucibles contained in glass-stoppered weighing bottles and again fused by placing the crucibles in a drying tube at 250°, through which passed a current of dry air. The crucibles and contents were then replaced in their weighing bottles, cooled, and reweighed. The original weight was usually lowered a fraction of a milligram due to the very slight hygroscopic nature of anhydrous lithium perchlorate.

The Solution of Hydrogen Chloride in Butyl Alcohol.—Butyl alcohol was treated with hydrogen chloride generated in the usual way by the action of conc. sulphuric acid on sodium chloride or conc. hydrochloric acid; 200 cc. of 20 per cent. solution could be prepared in two or three hours. For testing the strength of these solutions an hydrometer serves admirably. For use in this connection a density-concentration curve was constructed between the limits of 0 and 20 per cent. hydrogen chloride.

CONDITIONS AFFECTING THE PRECIPITATION OF SODIUM CHLORIDE FROM A SOLUTION OF SODIUM PERCHLORATE IN BUTYL ALCOHOL.

Several factors, some unexpected, were found to influence the quantitative separation of sodium and lithium from solution in anhydrous butyl alcohol by the addition of the solution of hydrogen chloride in butyl alcohol.

(To be Continued.)

[5] *Willard, Jour. Amer. Chem. Soc.*, 1912, XXXIV., 1480.

[6] *Richards and Willard, Jour. Amer. Chem. Soc.*, 1910, XXXII., 4.

CORRESPONDENCE.

ISOTOPES OF COPPER.

To the Editors of THE CHEMICAL NEWS.

GENTLEMEN, — Readers of this Journal may remember that I made an attempt to prove that copper was composed of whole-number isotopes in such proportion as to give a mean value as the atomic weight of this element, viz., 63.57. The values suggested in this Journal of March 20, 1914, page 143, were 63 and 67.

W. D. Harkins, in *The Journal of the American Chemical Society* for June, 1923, on page 1429, predicts the values 63 and 65.

Now, A. J. Dempster, in *Nature* of July 7, 1923, records having obtained positive rays of copper by means of a molybdenum furnace heated with a coil composed of molybdenum wire embedded in alundum cement. Three isotopes were observed, having provisionally the values 62, 64, 66.

Should Dempster's values be confirmed by further experiments, it will show the utter futility of attempting *precise* predictions based upon rather meagre evidence, but the general result indicated as far back as 1914 will have been confirmed.—Yours, &c.,

F. H. LORING.

NOTICES OF BOOKS.

Atomic Structure and Spectral Lines, by A. SOMMERFELD, Translated from the third German Edition (1922) by H. L. BROSE. Pp. XIII. + 626 and 125 Figures in text. London: Messrs. Methuen & Co., Ltd., 36, Essex Street, W.C.2. 1923. 32s. net.

It is one thing to possess a book and another thing to understand all that is in it. Prof. Sommerfeld's book, now a classic, contains much that requires very special study to understand fully, but there is a great deal of information clearly presented, thanks to the translator; and all who are interested in the fundamental characteristics of the atom, as studied and investigated more particularly by the physicist, should add this volume to their library, and study it.

In order that the reader may form some idea in advance of the scope of this work, the following sub-headings have been selected out of a total number of about 100: Atomicity of electricity; ions and electrons; photo-electric effect and its converse; glimpses of the quantum hypothesis; radioactivity; nuclear charge and atomic number; the atom as a planetary system; laws of radio-active displacement and the theory of isotopes; peripheral and central properties of the atom; visible and Röntgen spectra; configurations of the inert gases; Laue's discovery; survey of the K, L, and M series; corresponding limits of excitation; K series and its bearing on the periodic system; L and M series; doublet relationships; introduction to the quantum theory; empirical data about the spectra of hydrogen; principle of combination; Bohr's theory of the Balmer series; elliptic orbits in the case of hydrogen; quantising the spatial position of Kepler orbits; theory of the magneton; spherical wave and its propagation; conservation of energy and momentum; principle of selection and rule of polarisation; orbits of hydrogen in the Stark effect; Zeeman effect; quantum theory of the series scheme; principle of selection for the azimuthal quantum; testing the series scheme by the method of electronic impact; spectroscopic law of displacement and law of exchange; visible bands; meaning of the head of the band; law of the edge of the band; many lines spectra; preliminaries concerning the theory of relativity; variability of mass and inertia of energy; relativistic Kepler motion; fine structure and the relativity correction; doublets of the Röntgen spectra; spectroscopic confirmation of the theory of relativity, Bohr's principle of correspondence, &c.

Prof. Sommerfeld, as we all know, has developed a theory of the fine structure based upon Bohr's classical work in explanation of the spectra of hydrogen and helium, but the theory in some respect extends to all elements. In the "theory of the fine structures there is a confluence of the three main currents of modern research in theoretical physics, namely, the theory of electrons, the theory of quanta, and the theory of relativity. This is exhibited in a particularly vivid way in the way our *fine structure constant* α is built up:—$\alpha = 2\pi e^2/hc$. Here *e* is *the representative of the theory of electrons*, *h* is *the worthy representative of the quantum theory*, *and c comes from the theory of relativity* and, indeed, characterises it in comparison with the classical theory."—Page 525.

From the foregoing it will be seen that in developing a theory of the atom based upon electron movements, much of modern ph

sics has been brought into the problem, and on this account the book becomes a treatise of considerable scope.

Apart from the more rigorous treatment, there are ideas introduced in a suggestive way which will afford food for those in search of advance information. As an example, the question of two kinds of electricity is not made so evident by *current* electricity, which is a flow of electrons, for in terms of electrons the unity idea is prominent. In atomic physics, however, a positive charge signifies more than the absence of a negative charge, since "positive electricity is always associated with ordinary matter." The difference, therefore, implies "types of electricity that differ not only in sign but also in nature," which are individualised in the electron and the positively charged H atom. Quoting from page 22, "We can picture an atom (or a body) as highly charged negatively as we like, that is, we can add to it any number of negative electrons"; whereas, we can only increase the positive charge "to a certain maximum amount so long as we do not considerably alter the mass." We can remove from the atom only as many electrons as it possesses at the outset. According to the theory of relativity, *no* inherent or relative change in *charge* can take place. Electricity thus becomes a *substance*, but there are *two* such substances. "*The charge and the mass are hereby indissolubly associated with one another, the negative charge with the electronic mass, the positive charge with the hydrogen mass.*"

In discussing *polarisation*, Prof. Sommerfeld states that "it signifies that a ray favours a certain plane passing through it more than the one perpendicular to this plane." The early idea that Röntgen rays were longitudinal vibrations involves the scheme of symmetry, and therefore polarisation becomes impossible, since Barkla discovered that *primary* Röntgen rays are partly polarised, and that *secondary* Röntgen rays are wholly polarised in certain directions. The longitudinal vibration theory thus breaks down, and we are left with the interpretation that the direction of vibration does not correspond with the direction of motion of matter, but that the vibration is that of electric force which "participates in the wave-radiation." In wireless telegraphy the emission is zero in the direction of the alternating current, corresponding to its component of acceleration, but at right angles to the antenna the emission becomes a maximum.

The theory of *fine-structure*, which Prof. Sommerfeld has developed with great mathematical skill, follows when the Bohr theory of stationary states involving the quantum theory is analysed by means of relativity mechanics involving the change of mass of the electron with a change in its orbital velocity, so that those lines which were regarded as coincident become separated into a configuration of closely associated lines owing, as is evident, to the relativity effect involved. The velocity of the electron is less at the aphelion than at the perihelion, and this difference becomes greater as the eccentricity of the orbit increases. Quoting from page 475: "Thus the observation of the fine-structures discloses the whole mechanism of the intra-atomic motions as far as the motion of the perihelion of the elliptic orbits. The complex of facts contained in the fine-structures has just the same importance for the special theory of relativity, and for the atomic structure as the motion of Mercury's perihelion for the general theory of relativity." It is important to note that without the theory of relativity it would have been impossible to develop the theory of fine structure.

In a work of this magnitude errors are bound to occur in the first translated edition. These do not, however, detract from the value of the book. On p. 12, 5th line from top, *captivity* would be a better word than "capacity." Two lines further down, on the same page, the wording, "Although they here also soon," could be improved. On p. 23, the expression, "soup-plate," seems to imply a shape not strictly accurate, and it is not in dignified keeping with the subject.

On p. 84 it is stated that "*isotopic elements cannot be separated from one another by chemical means at all, and exhibit identical physical properties throughout.*" Atomic mass is a physical property and, in the case of some isotopes of a given element, it varies to the extent of eight units, as stated in the same paragraph. The above sentence is faulty in two respects; for (1), there are some physical properties which are not identical, and (2) the word *element* is more correctly used in a collective sense, and it should not be used synonomously with the word *atom* in this connection. An element is a collection of atoms of the same chemical kind with one common atomic number, except in the case of radio-active

elements which receive different names owing to their radio-active properties, or radio-active origins, differing.

On p. 101, 7th line from bottom, "*inner*" should read *outer*. On p. 102, 20th line from top, "elements" should read electrons. On the same page, and on p. 86, the practice of placing mass-numbers partly below the type line should be discouraged; they should be above it, or level with it, otherwise confusion with chemical notation arises. The meagre reference to Sir J. J. Thomson's pioneer work on the atom is a serious omission in a book of this scope. The general get-up and printing of the book leaves nothing to be desired. The up-to-date and complete X-ray-spectra tables in Chapter III. will be appreciated.

The Constitution of Matter, by MAX BORN, translated by E. W. BLAIR, D.I.C., B.Sc., A.I.C., and T. S. WHEELER, B.Sc., A.R.C.S.I., A.I.C. Pp. VII. + 80. London: Methuen & Co., Ltd., 36, Essex St., W.C.2. 1923. Price 6s.

This volume is based upon three important essays which Prof. Born has amplified and published in book form. The importance of the subject matter may be inferred from the fact that a second edition was soon demanded, and upon it the present translation is based.

An outline is given of the knowledge of atomic structure gained during the last few years, especially as the result of much patient investigation in the field of Atomic Physics.

The methods of measuring the charge and mass of an electron and the various models of atomic structure are described, together with such matters as the X-ray diffraction by crystals, and recent work on X-ray spectra.

Reference is made to the general theoretical development of the subject by Sommerfeld and by Kossel.

Prof. Born further develops his outline of the constitution of matter from a study of the inter-atomic forces in solids.

There is no index, but an extensive bibliography is appended to each section.

It will be realised that little more than a critical examination of the results of physical investigations in Atomic Science is possible in Prof. Born's admirable survey of the subject, which does not pretend to be an exhaustive account of all the Atomic ...s.

The Department of Scientific and Industrial Research has issued a *Report of the Fuel Research Board for the Years 1922-23. —First Section: The Production of Air Dried Peat*. Pp. VII. + 146. Price 5s. 4d. post free.

The investigations made since 1919 by Prof. Purcell and his assistant, Mr. E. J. Duffy, B.Sc., on the production and utilisation of air-dried peat are contained in this valuable report.

In 1921, the report of the Irish Peat Inquiry Committee was published, together with recommendations and other documents showing why it was not found possible to carry out the large experimental scheme of peat winning recommended.

Peat, as found in undrained Irish bogs, contains as much as 92 to 95 per cent. of water. Draining reduces it to between 8[illegible] and 91 per cent.

Peat cannot be usefully employed as a fuel until the moisture content is below 3[illegible] per cent. No economic method of drying by artificially generated heat is yet available, and where peat is used commercially it has been air-dried. The report, therefore, deals only with air-dried peat.

Mr. Duffy has investigated the properties of air-dried peat and the factors which govern the rate of drying of both hand-cut and machine-formed blocks. His report [illegible] given in an appendix.

Professor Purcell visited Canada in 192[illegible] to see the work the Canadian Peat Committee was carrying out for the Federal a[nd] Provincial Governments on the mechanical production of peat, and in 1921 and 1922 [he] visited Germany and Sweden for the purpose of studying the latest practices in the[se] countries. His reports are also given [in] appendices.

The winning of peat on a small scale h[as] been successfully practised from time i[m]memorial, but the problem of large sc[ale] production is far more difficult.

Professor Purcell has dealt with th[e] difficulties and has visualised possi[ble] schemes for peat winning on a scale [of] 100,000 tons per annum from one bog a[nd] over a period of years.

This report, which is very fully ill[us]trated, may be had from H.M. Station[ery] Office, Imperial House, Kingsway, W.[C.] and also from the provincial and colo[nial] offices and agencies.

Alcoholic Fermentation, by Arthur Harden, Ph.D., D.Sc., F.R.S. Pp. 194. London: Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 1923. 8s. 6d. net.

The subject of alcoholic fermentation has been of interest and importance from the earliest times.

Periodically in the development of scientific knowledge some great advance has been made towards the elucidation of the true mechanism of the chemical changes involved in this process.

One of the earliest discoveries was that of van Helmont who, in the 17th century, distinguished the evolution of carbon dioxide (gas sylvestre) in the course of alcoholic fermentation.

The next real step forward was made almost simultaneously (1837) but independently by three observers, Cagniard-Latour, Theodor Schwann, and Kützing, who demonstrated that the yeast which performed the fermentation was a living organism. This paved the way for Pasteur's researches, which mark the next advance, since he conclusively showed that there could be no fermentation without life.

Finally there is Buchner's discovery (1897) of the enzyme, zymase. This authority showed that the action of the yeast is *due to ferments secreted by the cells of the* yeast plant.

It is now further known that zymase, which is essential for the fermentation of sugar, only does so in the presence of a second body, called for want of a better term, the co-enzyme. The nature of this mysterious co-adjutor is at present unknown.

It withstands heating to 100° C., and is also dialysable and may be simpler in constitution than zymase.

Another essential condition for the fermentation of sugar, as Prof. Harden himself has proved, is the presence of a phosphate. The way in which this substance enables the decomposition of the carbohydrate into carbon dioxide and alcohol (and other substances) to occur is very ably described.

Prof. Harden's monograph constitutes a most important contribution to Organic Chemistry, and the border subject of Biochemistry. T.S.F.D.

Supplementary Notes on Gravimetric Analysis, by W. Lowson, B.Sc., F.I.C. Pp. 54. London: Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 1923. 2s. 6d.

In this little volume the author has collected together those important points in manipulative work, which are seldom given in ordinary laboratory manuals.

It is just these essential hints that enable the average student to acquire skill and accuracy in conducting quantitative analyses.

This section of practical chemistry is apt to become tedious to some students, especially if through lack of supervision or help they unconsciously neglect some apparently trivial operation, or accidentally introduce an error into their work, thus feeling discouraged by poor results.

The book should therefore be of service to demonstrators. It includes, in spite of its title, a chapter on the calibration of volumetric apparatus, as well as others on some typical Estimations and Occlusion.

The introductory section on Apparatus and Manipulation contains much useful information for beginners.

BOOKS RECEIVED.

A Treatise on Chemistry, by The Right Honourable Sir H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S. Pp. XII. + 829. Vol. II., Part I. 1923. Messrs. Macmillan & Co., Ltd., St. Martin's St., W.C.2. 50s. net.

A Treatise on Chemistry, by The Right Honourable Sir H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S. Pp. VIII. + 1,563. Vol. II., Part II. 1923. Messrs. Macmillan & Co., Ltd., St. Martin's St., W.C.2. 50s. net.

Organic Chemistry, by Ira Remsen, Revised and Enlarged by W. R. Orndorff, P:.D. Pp. XI. + 567. 1923. Messrs. Macmillan & Co., Ltd., St. Martin's St., W.C.2. 10s. net.

The Structure of the Atom, by E. N. da C. Andrade, D.Sc. (Lond.), Ph.D. (Heidelberg). Pp. XIV. + 314. 1923. Messrs. Bell & Sons, Ltd., York House, Portugal Street. W.C.2. 16s. net.

Quantitative Chemical Analysis and Inorganic Preparations, by R. M. Caven, D.Sc. (Lond.), F.I.C. Pp. VI. + 156. 1923. Messrs. Blackie & Sons, Ltd., 50, Old Bailey, E.C. 3s 6d. net.

The Paper-Makers' Directory of All Nations. Pp. XLIX. + 971. Thirty-second Edition. 1923. Messrs. Dean & Son, Ltd., Debrett House, 29, King Street, Covent Garden, W.C.2. 21s.

SYNTHESIS OF a-DIKETONES BY MEANS OF ORGANO-ZINC DERIVATIVES.

By E. E. Blaise.

The author has previously shown that the condensation of zinc propyl iodide with oxalylbisoxyisobutyryl chloride gave a mixture containing propyl-glyoxal and dibutyryl biscycloacetatoxyisobutyrates. After alcoholysis of the mixed products the latter remains alone. This formed a crystalline substance, which melted at 55-80°, and was a mixture of the internally compensated and the racemic isomers. These were only separated by slow crystallisation from methyl alcohol, followed by mechanical separation of the two kinds of crystals isolated. The pure substances melted at 72° and 82° respectively, and boiled at 168° C. under a pressure of 13 mm. The hydrolysis of the mixed isomers by means of hydriodic acid was accompanied by reduction, and propyl *n*-butyl ketone was formed, which boiled at 163° and gave a semicarbazone. This melted at 96° C. Hydrolysis by means of a mixture of hydrochloric and acetic acids gave a 60 per cent. yield of dibutyryl. It is a yellow liquid. b.p. 61.5° C. under a pressure of 14 mm. The dioxime melted at 181-182°, and the disemicarbazone not below 250°.

(*From Compt. rend.*, 1923, CLXXVI., 150.)

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

16138—Coley, H. E.—Reduction of sulphides. June 21.

Specifications Published this Week.

198705—Plauson, Dr. H.—Process and apparatus for the recovery of oils, bituminous matter, tar and resin from bituminous shale, oil-bearing sands, bleaching-earths, peat, brown coal, coal and wood.

198825—Chemische Fabriken vorm. Weiler-ter-Meer.—Process for impregnating wood.

198829—Soc. of Chemical Industry in Basle.—Manufacture of a new derivative of pyrazolone and of new dyestuffs therefrom.

198855—Royal Baking Powder Co.—Apparatus for effecting chemical reactions by means of amalgams.

198975—Vains, A. R. De.—Processes for dissolving the organic products obtained by the chlorination of cellulose material.

Abstract Published this Week.

197223—Sodium chromate.—Baumgartner, E., of 6, Kamstrupsti, Roskilde, Denmark.

Sodium chromate is obtained by heating in a current of hot air in a muffle, a mixture of chromium ore with sodium carbonate with or without lime or calcium carbonate. The materials are formed into briquettes and are arranged in the muffle, for instance, in rows with spaces between so as to allow contact with the current of air. Stirring or turning of the charge is unnecessary and undesirable and the operation is complete in one burning.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,

VOL. CXXVII. No. 3302.

BRIDGING THE GAP IN THE SPECTRUM.*

Hertz's classical experiments with elec-ric waves in 1888 not only paved the way or the development of wireless communi-ation, but showed that these waves, as in-icated by Maxwell's electromagnetic heory of light, were waves of the same kind s light, for they could be bent by prisms nd shown to be a part of a spectrum. The lectric waves which Hertz produced in his aboratory were 60 cms. long.

It was not until 1895 that Lebedew ob-ained electric waves which had a length of mms. Lampa, about the same time, had roduced waves of 4 mms. in length. Möbius, in 1918, confirmed the general re-ults of the two foregoing investigators, but e came to the conclusion that their waves ere respectively 10 and 7 mms. long. Möbius, from experimental considerations, educed evidence that in this case anything horter than the above were ripples as dis-nct from regular waves.

At this time, following Langley's re-earches on the solar spectrum, Rubens and aschen investigated the infra-red end of he spectrum and detected waves 9.4μ, hich is 16 times longer than the wave-ength of yellow light.

In 1897 Rubens and Nichols, by means of multiple-reflection method, succeeded in xtending the boundaries of the infra-red pectrum ten-fold. Then the former inves-gator obtained a further extension by em-loying Wood's method of focal isolation. ollowing on this, Rubens and von Bayer, n 1911, measured infra-red waves up to .320 mm. in length.

There remained a gap between the heat aves and those produced by electrical ap-aratus, but this gap Nichols and Tear have ow bridged by electrical waves, using a ethod which is briefly described in the *roceedings of the National Academy of ciences of U.S.A.*, Vol. IX., No. 6, June, *Rev.*, 1896-7, Vol. IV., p. 297), which re-ceived the waves. The usual blackened vanes in this radiometer were replaced by mica strips, on which were deposited bright metallic platinum. By shielding the vanes on one side, their rotation was obtained, as the action of the electric waves produced oscillating currents in the metal, which per-ceptibly heated it owing to its ohmic re-sistance, and thus gave rise to the well-known radiometer action. The short elec-tric waves were generated by means of a Hertzian doublet with minute tungsten cylinders substituted for platinum. The wave-length measurements involved the use of a new form of reflecting echelon analyser.

By means of the equipment briefly sketched above, Nichols and Tear were able to produce and measure *electric* waves down to 0.220 mm. in length, which is "shorter than the longest known heat waves emitted by matter at high tempera-tures." In a check experiment on the ap-paratus, these investigators exposed their electric-wave receiver to Rubens' and von Bayer's *heat waves* of 0.320 mm. in wave-length, and obtained "results identical with those recorded by these earlier investi-gators."

The range represented by the shortest wave-length, that of gamma rays (γ rays) from radio-active matter, to that of the longest Hertz waves, is now practically ex plored throughout. The ratio of the short-est wave-length to the longest wave-length is about 1 to 20 million billion.

"Matter under the action of heat is capable of giving off radiations in the so-called *infra-red*, visible, and ultra-violet spectra; gamma rays are the natural accompaniment of radio-active disintegration, and there are various electric phenomena in the atmos-phere giving rise to pulse-like disturbances resembling fragments of very long electric waves. But X-rays and the old and new short electric waves we may still regard as artificial, or purely products of laboratory manufacture."

* *Compiled from Nichols and Tear's paper n the "Proceedings of the National Aca-emy of Sciences of U.S.A.," Vol. IX., No. 6, June, 1923.*

THE INSTITUTE OF PHYSICS.

At the last meeting of the Board the fol-lowing Corporate Members were elected:—Fellows: C. H. Desch, M. Fishenden, W. M. Jones, S. Marsh; Associates: R. P. Black, M. Brotherton, J. F. Congdon, D. E. Jolin, H. Lowery, S. P. Peters, L. J. Sutton, N. W. Turnell, A. Whitaker, L. Wright.

THE BRITISH DYE INDUSTRY.

During a recent debate on the Board of Trade vote in the House of Commons, Mr. Clayton, the Unionist member for Widnes, referring to British dyes, said that we had all the raw materials for the dye industry in this country, and there was no reason why those dyes which were made before the war in Germany could not be made here. Enormous progress had already been made, and the dye-users agreed that under the help and guidance of the present Board of Trade they would yet establish a dye industry in this country which could hold its own with any other. The intermediates for these dyes were necessary for explosives, and if the dye industry was maintained in this country we should have valuable materials at our disposal in case of emergency. Before the war in Germany it was part of the Army manœuvres to turn the dye-works into explosive factories. He maintained that the chief opposition to this subsidy came from the merchants who supplied German dyes.

Sir P. Lloyd-Greame, President of the Board of Trade, said that the value of the dye industry to the textile industry of this country was greater than ever before. The occupation of the Ruhr had taken place, and great uncertainty existed as to whether the dyes would come forward at all. He knew one company which had been manufacturing day and night almost since the occupation to supply the things that were needed. The textile trade would have been in a very anxious position in the last six months if it had existed entirely on dyes coming from the Continent. It had been said that the dyes that were being used in Lancashire were bad, but the Chairman of the Dye Users' Association had paid a tribute of admiration to the makers for the progress achieved in the production of dyestuffs in the last few years. Our pre-war consumption of German and other foreign colours was 70 to 80 per cent. of the total, and last year we used 70 to 80 per cent. of British dyes, this change having been effected without in any way reducing our standards.

STUDIES ON THE PHYSICAL FOUNDATIONS OF DEEP THERAPY TREATMENT.

By Prof. Dr. Friedrich Dessauer

(Director of the Institution for the Study of Physical Laws of Medicine, University of Frankfort, Frankfort-on-the-Main, Germany.)

Study of the Pyhsical Conditions.

The paper dealt first with the physical laws of irradiation and the exact knowledge of the distribution of the rays within the tissues.

The second line of study covered the technical requirements for a practical solution of the problem. I have been working in Germany on the development of the apparatus, and have spent many years of thought on producing one that would generate very high voltages and would operate continuously without change under conditions of absolute safety and within small dimensions; that is, an apparatus which could be used by the medical man without danger and without great expense for operation and upkeep. In the meantime [illegible] friend and co-worker, Dr. W. D. Cool-[illegible] still further developed his wonder- most accurate results, and with which I could bring to their best effect the high voltages. This subject will be covered in my second paper.

Before arriving at my last results, I shall briefly touch upon the history of how the problem started. In 1904, nearly seventeen years ago, I first formulated the problems. At that time superficial skin diseases were being treated with Röntgen rays. The results were not satisfactory, and Professor Perthes published interesting experiments, coming to the conclusion that an insufficient quantity of rays penetrate to a depth. I naturally approached the problem from the physicist's point of view.

The *Laws of Homogeneous Irradiation* were the foundation for the development of deep therapy, and have to-day proven to be true. To-day it is very simple and natural, but it was not so seventeen years ago, when the nature of Röntgen rays was unknown and their laws could not have been known. Amongst those who had grasped at the first the importance of the physical laws of deep therapy and had made use of them consciously, I should like to mention Beclère of Paris and Wetterer of Mannheim.

The laws of homogeneous irradiation are in abbreviated form the following:

First Law.—The foundation of Röntgen-

perience that different cell forms show different sensitiveness to the same Röntgen rays.

Second Law.—Rays of different penetration are to be regarded as different medicaments, so long as the contrary is not proven. The difference in sensitiveness of different cells appears more marked if hard rays are applied.

Third Law.—In order to determine and utilise precise differences in sensibility, the *homogeneity of the field of radiation* is a required condition.

Fourth Law.—The non-homogeneity of a treated field detracts from the effect. The conditions for a favourable influence upon the disease are not fulfilled when the non-homogeneity of the field is greater than the difference in sensitiveness between the diseased cells and the healthy.

This law, the law of the *limit of effect*, can easily be expressed by algebraic formulæ.

Fifth Law.—There is a homogeneity of space or quantiative homogeneity and a specific homogeneity, or qualitative homogeneity. The aim must be to dose the diseased zone throughout its extent with the needed quality or dose of irradiation, and to have this dose of the same quality throughout.

Sixth Law.—The condition of qualitative or specific homogeneity is fulfilled when the irradiation in the complete zone during its course through the body does not change its composition or consistency. The reaction on the different cells is then physically only dependent on the *intensity and the time*.

Seventh Law.—The intensity of effect may not differ more than the degree of sensitiveness. This is only a more precise statement of the fourth law, the *limit of effect*, but one may try to increase the intensity on the diseased zone in the depth and to raise it above the intensity on the surface, and in the vicinity of diseased cells.

Having *a well-known composition of rays we have measured the distribution of the intensity of irradiation within a body.* These measurements have been made with four kinds of rays—the most penetrating which up to then could have been produced continuously. Five focal distances were studied each for three different-sized treatment fields—small, medium, and large.

(*From "The American Journal of Roentgenology,"* Vol. VIII., No. 10, October, 1921, pages 578-588.)

AGRICULTURAL MACHINERY EXHIBITION AT PARIS.

The Department of Overseas Trade is in receipt of information that the Third Agricultural Machinery Exhibition will be held in Paris in January, 1924.

This exhibition, like those held in 1922 and 1923, will include agricultural machines and implements manufactured in France or in countries which were allied, associate or neutral during the war.

Applications for space will be received up to October 15 next, by the Commissariat General, 8 rue Jean Goujon, Paris (8e).—(*From the "Board of Trade Journal," July* 12, 1923.)

INTERNATIONAL SAMPLES FAIR AT ZAGREB.

The Department of Overseas Trade is informed that the Third International Samples Fair is to be held at Zagreb (Agram), Jugo-Slavia, from April 27 to May 5, 1924.—(*From the "Board of Trade Journal," July* 12, 1923.)

CANADA.

Surgical Instruments and Hospital Supplies for Vancouver, B.C.

H.M. Trade Commissioner at Vancouver reports that a firm in that city is desirous of receiving from United Kingdom firms, catalogues, prices, etc., relative to surgical instruments and hospital supplies. Further particulars can be obtained on application to the Department of Overseas Trade (Room 53), 35, Old Queen Street, London, S.W.1.

RAPESEED OIL REQUIRED IN U.S.

Mr. G. Campbell, H.M. Consul-General at San Francisco, reports that a local firm of import and export merchants are desirous of receiving c.i.f. quotations for linseed and refined deodorised rapeseed oil. In the case of the former, the company wish to deal with London exporters alone, and in the case of the latter only with manufacturers.

British firms desirous of receiving further particulars of this enquiry should apply to the same Department. (Reference 20066/F.W./C.C.2.).

OBSERVATIONS UPON AND DEDUCTIONS FROM THE FIGURES GIVEN IN THE INTERNATIONAL TABLE OF ISOTOPES, 1923.

By Hawksworth Collins.

In this paper it is inferred that all the figures given in the International Table of Isotopes, 1923 (which appeared in *The Chemical News*, 1923, CXXVI., 147), are results obtained by independent experiments, and that no one of them is merely the result of hypothesis; *e.g.*, 18 has been obtained by independent experiment as the atomic number of Argon. If it has not been so obtained, it would not have appeared in the table, for the duty of the new Committee is "to keep chemists informed of the various advances made each year in this field," and the word "advances" evidently does not include anything of the nature of hypothesis.

Table I.

Element	Atomic Weight	Dominant Isotope	Remark	Atomic Number	Remark	Maximum Valency	Remark
He	4.00	4	even	2	even	2	even
Li	6.94	7	odd	3	odd	1	odd
Gl	9.1	9	odd	4	even	3	odd
B	10.9	11	odd	5	odd	3	odd
C	12.005	12	even	6	even	4	even
N	14.008	14	even	7	odd	5	odd
O	16.000	16	even	8	even	2	even
F	19.0	19	odd	9	odd	1	odd
Ne	20.2	20	even	10	even	0	even
Na	23.00	23	odd	11	odd	1	odd
Mg	24.32	24	even	12	even	2	even
Al	27.0	27	odd	13	odd	3	odd
Si	28.1	28	even	14	even	4	even
P	31.04	31	odd	15	odd	5	odd
S	32.06	32	even	16	even	6	even
Cl	35.46	35	odd	17	odd	7	odd
A	39.9	40	even	18	even	0	even
K	39.10	39	odd	19	odd	1	odd
Ca	40.07	40	even	20	even	2	even
Fe	55.84	56	even	26	even	6	even
Ni	58.68	58	even	28	even	3	odd
As	74.96	75	odd	33	odd	5	odd
Br	79.92	79	odd	35	odd	7	odd
Rb	85.45	85	odd	37	odd	3	odd
I	126.92	127	odd	53	odd	7	odd
Cs	132.81	133	odd	55	odd	5	odd

Observation 1.

When the atomic number is even, the masses of the isotopes are even whole numbers; and when the atomic number is odd, the masses of the isotopes are odd whole numbers; with a few exceptions.

There are 70 numbers given for the masses of the isotopes (not including the doubtful ones in brackets, and excluding also the mass of hydrogen which is not [illegible] as a whole number), and of these, 12 [illegible]ptions to the above general rule. If [illegible] know whether this general rule [illegible] [illegible]uth, we must proceed in the [illegible]er:— [illegible] that, when the atomic number is even, the mass of the isotope would accidentally also be even is 1 : 2, and that when the atomic number is odd, the isotope would also be odd, is 1 : 2. Therefore the probability that the above regularity would happen accidentally in 58 cases out of 70 is 1 : $2^{70-[illegible]+12}$ = 1 : 2^{46} = 1 : 70 billion.

So, the probability that this state of affairs has not happened by accident is 70 billion to one, that is, it is absolutely certain that a truth is contained therein.

Deduction 1.—Therefore, with the advance of knowledge, the exceptions will probably diminish; *e.g.*, the single odd iso-

tope of Se may be found later to be an impurity and not Se at all.

Deduction 2.—There is some fundamental and uniform connection between the atomic number of an element and its isotopic masses, and this connection must be expressible by whole numbers.

In the case of Li, whose atomic weight is given as 6.94, and whose isotopes are 7 and 6, it is evident that the majority of the isotopes must have masses of 7. A similar remark can be made in the cases of several other elements. Omitting those to which such a remark cannot be applied, the figures for dominant isotopes (given in Table I.) are obtained.

OBSERVATION 2.

When the atomic number is even (or odd) the dominant isotope is correspondingly even (or odd) in 24 cases out of 26.

The probability that this contains a truth is $2^{26-2\times2} : 1$ = four million to one.

Deduction 3.—There is some fundamental and uniform connection between the atomic number of an element and the mass of its dominant isotope, and this connection must be expressible by whole numbers.

The maximum valences given in Table I. are universally recognised as such.

OBSERVATION 3.

When the atomic number is even (or odd), both the dominant isotope and also the maximum valency are correspondingly even (or odd) in 23 cases out of 26.

The probability that this contains a truth is $4^{26-\frac{3\times4}{3}} : 1$ = 17 billion to one.

This can be seen to be correct by the following consideration. If it were merely a matter of accident, only one out of every four elements would be likely to have 3 evens or 3 odds. Therefore, in 26 elements, 6.5 (=26/4) would be likely to satisfy this condition; so that there would be 19.5 exceptions. (The fact that 19.5 is not a whole number does not affect the reasoning, of course). The probability would then be $4^{26-\frac{19.5\times4}{3}} : 1 = 4^0 : 1 = 1 : 1$, which is evidently correct.

Deduction 4.—There is some fundamental and uniform connection between the atomic number of an element, the mass of its dominant isotope, and its maximum valency, and this connection must be expressible by whole numbers.

The following observation applies exactly to all but three of the first 19 elements in Table I., *i.e.*, to the great majority of the common elements.

OBSERVATION 4.

The atomic number gives the number of 3's and 1's into which the mass of the dominant isotope can be split up, always commencing with a 3, and taking the 3's and 1's *alternately*.

E.g., the atomic number of B is 5, and its dominant isotope can be split up into 5 parts, 3+1+3+1+3; the atomic number of Mg is 12, and its dominant isotope can be split up into 6(3+1), i.e., into 12 parts.

This state of affairs continues as far as Ca, when there is an abrupt change, and occurs no more at all in the elements of atomic weight greater than 40.

The probability that there is a truth involved in this observation is infinitely greater than $2^{19-2\times3} : 1$ = 8000 : 1, because it is a complex regularity.

OBSERVATION 5.

If the mass of the dominant isotope is an even number, the atomic number is obtained by halving it. And, if the mass of the dominant isotope is odd, the atomic number is obtained by subtracting one and then halving the result.

This state of affairs continues again as far as Ca, when there is an abrupt change, and occurs no more at all in the elements of atomic weight greater than 40.

The probability that there is a truth contained in this observation is $2^{19-2\times1} : 1$ = 130,000 : 1, for there is only one exception, *viz.*, Argon.

Deduction 5.—It follows from the last two observations that the majority of the common elements of atomic weight less than 41 are differentiated absolutely from all other elements by some fundamental property or properties. Either this is the case, or the atomic numbers from Fe upwards are wrong. But since chemists are convinced that the properties of all elements are periodic functions of their atomic weights, they cannot admit that there is any fundamental regularity which belongs solely to those elements which happen to have atomic weights less than 41. Therefore the atomic numbers from Fe upwards must be wrong.

It is not merely extraordinary, but it is also quite absurd, that a complex general rule connecting the atomic weight with the atomic number should apply only to those elements which happen to have atomic weight less than 41, and which also happen to include nearly all the common elements.

Deduction 6. — The fourth observation evidently contains the fundamental and uniform connection, which has been proved to exist between the atomic number of an element and its dominant isotope, for there is no other uniform arrangement of whole numbers possible; and this is especially suitable, since it is known that one electro-positive force emanates from a mass of 1(1.008), also one from a mass of 3(H_3), also two from 4(He).

OBSERVATION 6.

If helium, with its two electro-positive forces, could be given off from the heptad Cl (35), a pentad would be left with atomic weight 31. The pentad P has at. wt. 31.

If helium were given off from the pentad P, there would be left a triad with at. wt. 27. The triad Al has at. wt. 27.

If helium were given off from the triad Al, a monad would remain of mass 23. The monad Na has at. wt. 23.

If helium were given off from the hexad S (32), there would be left a tetrad of mass 28. The dominant isotope of the tetrad Si has mass 28.

If helium were given off from the tetrad Si (28), a dyad of mass 24 would remain. The dominant isotope of the dyad Mg has mass 24.

If helium were given off from the dominant isotope (11) of B, a monad of mass 7 would be left. The dominant isotope of the monad Li has mass 7.

OBSERVATION 7.

In all the above six examples, which are exact, the element which is supposed to be disintegrated has 2, 4, or 6 electro-positive valences, which always act in pairs, and which cause these elements to be classed as non-metallic.

The discovery involved in the last two observations was first published in an advertisement in *Nature* on June 14, 1906, long before chemists admitted that the atomic weights were whole numbers, or that the elements could be disintegrated, also several years before it was known that helium possessed two electro-positive valences. This new chemical law was worded as follows: "The non-metallic nature of an ele- [illegible] is always due to a pair or pairs of [illegible]sitive forces, each pair emanat[illegible] portion of the element of which [illegible] taking the mass of an atom [illegible] unity."

If any chemist were asked to name three elements which are especially similar to one another, considering only the 33 given in the International Table of Isotopes, there is not much doubt that he would choose either Cl, Br and I, or K, Rb and Cs. It was shown in *The Chemical News*, Jan. 16, 1914, and Oct. 1, 1920, that Na (23) takes a prominent part in the formation of all elements of greater atomic weight than itself. This was done at a time when chemists objected to the mathematical proof that the atomic weights were whole numbers; but now that this difficulty has been almost entirely removed, the demonstration of the matter is much simplified.

OBSERVATION 8.

Element	Isotopes	Observation
Cl	35	
Br	81	$81 = 2 \times 23 + 35$
I	127	$127 = 4 \times 23 + 35$
K	39; 41	
Rb	85; 87	$85 = 2 \times 23 + 39$ $87 = 2 \times 23 + 41$
Cs	133	$133 = 4 \times 23 + 41$

Deduction 7:—

Br = Na_2Cl
I = Na_4Cl
Rb = Na_2K
Cs = Na_4K

All these observations are matters of fact. There is no hypothesis, speculation, or guesswork involved in them. Also there is no arbitrary choice of facts; for all available data are employed, whether favourable or unfavourable.

There can be no valid objection to exceptions to general rules with respect to the structure of the elements, for there is no reason why all elements should be built up in exactly the same manner.

When a state of affairs has been proved to be due to cause and not to chance, it is evident that no future discoveries or additions to knowledge (such as isotopes, *e.g.*) can ever contradict the general truth obtained, for it is impossible for scientists to unconsciously evolve a state of affairs which can be proved to be due to cause and not to chance, and yet for it not to contain an absolutely incontrovertible truth.

The explanation of the odd and even observations evidently is: that if an even number of 3's and 1's be added together the result is even, and if an odd number of

3's and 1's be added together the result is odd.

From the above and additional observations, other deductions leading to the definite demonstration of the Constitution and Structure of the Elements were given in papers published in *The Chemical News*, Dec. 19 and 26, 1919, April 9, June 4, Oct. 1 and 15, 1920, etc.

THE ANNUAL MEETING OF THE ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS.

The Seventh Annual General Meeting of the Association was held at the Chemical Society's rooms on July 12. Sir Max Muspratt, Bart., Chairman of the Association, presided.

In proposing "That the report and accounts of the Association be and they are hereby adopted," the Chairman said the Association's sphere of usefulness is constantly increasing.

In spite of being chemical manufacturers, we have in recent years somewhat overcome the modesty of previous eras of chemical industry, and we believe that we have a message of a two-fold nature to give to the nation. We have a duty to perform in instructing Ministers and other members of the Government and the Civil Service as to what they ought to know about this most important industry. We have also to impress upon the nation at large that in Great Britain the chemical industry is a very important national asset, and, like every other important national asset, it has to go forward or go back. We intend, by every means in our power, to further the progress of this industry.

The British Industries Fair of 1923 is dealt with in the report, but I might accentuate the fact that in the British Industries Fair, both this year and on previous occasions, we have tried to carry out the policy of showing the close interlocking of the various branches of the chemical industry, and I believe at the recent British Industries Fair we carried that out to no small extent. The British Industries Fair is, we hope, an annual factor, but next year when the British Empire Exhibition also takes place, we felt that it would be calling too much upon our members to make an adequate chemical section on both those occasions, and so we are not taking part in the Fair of next year. In the British Empire Exhibition of 1924 we are taking a very great part. We intend the Chemical Section of the British Empire Exhibition to be a complete survey of Britain's services to chemistry, from the smallest chemical manufacturer to the most brilliant and epoch-making discovery by scientific men in chemistry. It will be one of the most complete exhibitions of chemistry in its broadest sense that has ever been brought before the British public—greater than has been presented anywhere before. When I tell you that the Royal Society is going to take part in an exhibition, I think you will admit that we are bringing even the academic section of chemistry into the services of mankind and the Empire. The Chemical Society is, of course, assisting us; the Society of Chemical Industry; the Society of Petroleum Technologists; the Pharmaceutical Society; the Society of Dyers and Colourists are all assisting, and, from the Royal Society, Sir Herbert Jackson is *liaison* officer in conjunction with our General Manager, to see that the most complete linking up in absolute harmony of every aspect of chemistry is duly and properly carried out at the British Empire Exhibition next year.

With regard to the Continental situation, I believe that a few words will be said about that in another place to-day, and by one (the Prime Minister), who was a guest at our dinner last year. I need only deal with it purely from the aspect of chemical industry. The whole position of the Ruhr is one which the chemical industry, especially the fine chemicals and the dyestuff branches of the industry, has to look upon with great apprehension. There are superficial advantages in having competitors closed, but I am sure that nobody with the broad training of a chemist will for a moment take that aspect. On the purely material side, it is even better to have the chemicals in the hands of a competitive manufacturer than to have them in the hands of an irresponsible Government Department, and when that irresponsible Government Department is not even in this country, I need hardly say that what is going to happen to those dyes and other chemicals which have been taken by the French Government is causing grave doubt and grave uneasiness in the minds of everyone connected with the

Council of the Association of British Chemical Manufacturers.

I will not elaborate the paragraph in which the Dyestuffs Act is dealt with except to refer to the agitation for the repeal of that Act, and to ask if the real trouble of the textile industry is not the high price of cotton. I know I am speaking for everyone occupied with the heavy chemical industry in assuring him and his colleagues in other branches of the dye industry that the heavy chemical industry does desire to assist and co-operate with them in every possible way.

Turning to the question of alcohol, which has been discussed for years, and especially for months past, I should like to say how deeply we are indebted to Mr. Carr for the way in which he has handled this problem in conjunction with the Committee. It would be absolutely invidious to mention names, but I know that everyone of you will wish to add in your vote on this written report a vote of appreciation to the able staff who manage our affairs.

Mr. R. G. Perry, C.B.E., in the absence, owing to illness, of the Vice-Chairman, Sir William Pearce, seconded the resolution. He said there was only one point to which he would like to refer. It was the paragraph in the report which read: "The Council records with satisfaction and appreciation the honour which has been conferred by His Majesty the King upon its Chairman, Sir Max Muspratt, Bart." They all wished to congratulate their Chairman upon that honour. They were all quite sure that never had an honour fallen upon more worthy shoulders, and never would an honour be more worthily borne.

The Treasurer (Mr. C. A. Hill), in commenting on the accounts, said that, in case it should be thought they were working on too narrow a margin, he would like to put forward the view that that was a matter for congratulation to the administrative staff who were responsible for the working of the Association.

Mr. A. T. Smith said there was one matter of which they should make a special note, and that was the remarkable result which has followed their efforts as an association to better the chemical trade. They had one very particular instance to record, and it arose from the speech by Sir William Alexander, as Chairman of the British Dyestuffs Corporation. He (Mr. Smith) did not contend that the results were due to the efforts of the Association, but he did sa that the fact that the Association lived an existed and did co-operate and help in ever possible way, must have been of the utmos assistance to Sir William Alexander in th very arduous work he had undertaken. H might be perfectly certain, as far as th heavy chemical industry was concerned that he would have the same co-operati in the future as he has had in the past, an he hoped the results would be quite a good.

Dr. E. F. Armstrong, F.R.S., said tha the Association had certainly done we during the year, but it was desirable tha chemical industry should try to stand on it own feet. He did not mean to criticise th policy of the Association in the past. S William Alexander, in the few words whic he addressed to the shareholders of th British Dyestuffs Corporation, mentione that a sum of £400,000 had been spent o research. The fact that it has been sper showed that one firm in this country rea ised the enormous importance of making it self strong on the scientific side as a pr liminary to its success financially. It wa only by research and by its technical wor that they could get an advantage in th future. Whatever the Association did a its primary object, in the representation o the chemical industry as a whole, the Gov ernment must never lose sight of its secon ary object, namely, the encouragemen first to co-operation, because that is th secret to other things, as Mr. Smith had i dicated; and secondly, the encourageme of technical progress within their industry.

Sir William Alexander, K.B.E., C.B C.M.G., D.S.O., said his company had re ceived from the large members of the heav chemical industry in recent times very re and concrete assistance in bringing dow the prices of their products. In every cas where it had been at all possible for the to meet the company they had done so, an in every case where it has been possible f the company to pay a higher price, they ha paid it. He felt certain that their industr was going to pull through. He hoped th their industry would be of assistance to th other large industries which were embrace in the Association of British Chemic Manufacturers, and that as time went o they would find that they merited the co fidence which was being placed in them.

The Rt. Hon. J. W. Wilson alluded to the last two paragraphs in the report with regard to transport.

Mr. F. H. Carr, C.B.E., F.I.C., referred to the alcohol question. The importance of alcohol to the fine chemical industry had perhaps never been stated, and yet he thought that chemical manufacturers and fine chemical manufacturers in particular were coming to realise that it was a substance, as a chemical, which they could use, whereas hitherto it has always been regarded as a substance which was beyond their reach. Many still believed that the chief use of alcohol was as a beverage. Chemists and Americans did not believe that. It was the raw material, the coal tar, of the pharmaceutical chemical. The ethyl group entered into a large proportion of the synthetic compounds used in medicine, and hitherto the manufacture of such compounds had been practically impossible owing to the difficulties which had been met with in the early stages of manufacture in getting satisfactory arrangements with the Excise Authorities. The work that had been done by the Committee had only been possible because of an entirely new state of affairs at the Board of Customs and Excise, and it was to such people as Sir Horace Hamilton and Sir Robert Robertson that their thanks must be chiefly given. They had in the concessions which they had given shown that we are at the dawn of a new era as regards the use of alcohol in chemical manufacture. The concessions which had been made permitted manufacturers who are commencing to use alcohol to use quantities up to 100 gallons without any restrictions as regards their receivers without the necessity of an officer being on the spot; and provided adequate figures were shown as regards the destination of the alcohol that was being used, they were quite satisfied to leave it with fairly moderate restrictions. He urged all those interested in fine chemical manufacture to make use of these privileges and to lay before the Association such difficulties as they might meet with in order that the Committee might go on with this work until they got every possible facility required for their manufacture.

Mr. Kenneth Chance, M.A., associated himself with the remarks of Mr. Wilson as to the question of transport.

Mr. E. V. Evans, O.B.E., F.I.C., expressed on behalf of the Society of Chemical Industry its appreciation of the help and contributions made by the Association to its Journal.

Dr. H. Levinstein, M.Sc., referred to a sentence in the report stating: "The Council has been asked, and has agreed, to organise the Chemical Section of the Exhibition to be held at Wembley next year." That was a remarkable testimony to the Association. The mere fact that when they had a British Empire Exhibition the whole of the chemical exhibit could be dealt with by one organisation of this kind showed what an enormous stride the chemical industry had made in organisation since the last exhibition of the same kind was held. He had not the slightest doubt that this chemical exhibit would make the same impression on chemists visiting the British Empire Exhibition as the wonderful exhibit shown by the Germans in Paris in the year 1900, which no doubt many of them remembered.

Mr. Bernard Hickson endorsed the remarks with regard to transport.

Mr. T. D. Morson said that as a backbencher he hoped that publicity would remain in the fore-front of the policy of the Association.

The Chairman, having briefly replied, then put the motion to the meeting, and declared the report and accounts unanimously adopted.

The Ordinary Meeting was followed by a Special General Meeting, when the amount of the annual subscription payable by members of the Association for the year 1923-1924 was fixed at four-fiths of the sums laid down in Article 17 of the Articles of Association.

Sir John Brunner, Bart., proposed, and Mr. R. G. Perry, O.B.E., seconded, a vote of thanks to the Chairman, which was carried unanimously, and the proceedings then terminated.

THE SEPARATION AND DETERMINATION OF SODIUM AND LITHIUM BY PRECIPITATION FROM ALCOHOLIC PERCHLORATE SOLUTION.[1]

By H. H. Willard and G. Frederick Smith.

[*Contribution from the Chemical Laboratories of the University of Michigan and the University of Illinois.*]

(*Continued from Page 43.*)

It was found to be sufficiently close to a straight line function so that values be-

tween those given in the following table could be obtained by interpolation.

TABLE I.

Density of Solutions of Hydrogen Chloride in Dry Normal Butyl Alcohol.

HCl %	Density	HCl %	Density
0	0.8060	11	0.8685
1	0.8130	12	0.8930
2	0.8195	13	0.8770
3	0.8255	14	0.8810
4	0.8315	15	0.8855
5	0.8370	16	0.8895
6	0.8425	17	0.8935
7	0.8485	18	0.8960
8	0.8540	19	0.9010
9	0.8590	20	0.9050
10	0.8635		

These values were obtained by using a pycnometer and thermostat and refer to 25°/4° corrected to vacuum. The hydrochloric acid was determined by titration with standard alkali.

The factors in the order of their importance are: (1) temperature of precipitation; (2) concentration of hydrochloric acid, giving minimum solubility of of sodium chloride; (3) conditions favouring ease of filtration; (4) prerequisites or drying and ignition of the sodium chloride obtained; (5) physical constants of butyl alcohol used in the method; (6) treatment of filtrates from sodium chloride for recovery of lithium. These factors will be taken up in the order given.

Temperature of Precipitation.—Sodium chloride precipitated from boiling solutions of sodium perchlorate in butyl alcohol when filtered on asbestos, washed, and dried at 250_4 for a long time, is perfectly white, but upon ignition to 500-600° it becomes dark grey, and when then dissolved in water a black deposit of carbon is obtained. This results from occlusion of solvent in the precipitated sodium chloride. The error in weight of the precipitated sodium chloride, due to this cause, is variable and too large to be neglected. Precipitation at room temperature gave a similar result, but much less carbon was obtained. Wash solutions such as acetone, ether and carbon tetrachloride, are incapable of removing the occluded solvent from the precipitate. Ignition of the sodium chloride containing carbon in a stream of oxygen did not remove the impurity. The lower the temperature of the solution from which sodium chloride is precipitated, the less the tendency it shows to occlude solvent. When precipitated at —15° to —20° the dried and ignited salt contains no carbon but is pure sodium chloride.

Effect of Acid Concentration Upon the Solubility of Sodium Chloride.—Solutions of sodium perchlorate of known content were precipitated by the addition of butyl alcohol containing 20 per cent. of hydrogen chloride. A definite excess of hydrogen chloride was then added over that required for precipitation. After being heated to boiling, the precipitated samples were cooled to room temperature, filtered through asbestos, and washed with solutions of hydrogen chloride in butyl alcohol o the same strength as those from which the sodium chloride was precipitated. The precipitate was dried at 250°, ignited at 500-600° and the sodium chloride found, corrected for its carbon content, was compared with the amount present. The concentration of hydrogen chloride was gradually increased, until at 6 per cent. to 7 per cent. the solubility of sodium chloride reached a minimum of 0.6 mg. per 100 cc. This excess of hydrogen chloride can be obtained closely enough by adding to the solution of the perchlorate half as many cc. of 20 per cent. solution of hydrogen chloride in butyl alcohol, as there are grams of the solution. The wash solution is made in the same way.

The solubilities of the various salts involved are shown in the following tables:

TABLE II.

Solubilities in Anhydrous Normal Butyl Alcohol at 25°.

	G. per 100 g. solution.	Density 25°/4°.
$LiClO_4$	44.23	1.1341
$NaClO_4$	1.83	0.8167
LiCl	11.49	0.8713
NaCl	0.014_x	0.8060

x 0.0116 g. per 100 cc.

[1] *The work done in connection with this paper was suggested by H. H. Willard, and the preliminary work was carried out at the University of Michigan. The final work was done at the University of Illinois.*

TABLE III.

Solubility of Sodium Chloride Precipitated from Anhydrous Butyl Alcohol Containing 6 per cent. of Hydrogen Chloride.

	NaCl taken G.	NaCl found G.	Vol. filtrate and washings¶ Cc.	Free $HClO_4$ present %	$LiClO_4$ present G.	Solubility of NaCl in 100 cc. G.
1	0.3021	0.3007	102	—	—	0.0014
2	0.3004	0.2989	110	—	0.1720	0.0014
3	0.3031	0.3020	102	—	—	0.0011
4	0.3510	0.3493	87	—	0.0356	0.0019
5	0.1549	0.1546	52	0.5	—	0.0006
6	0.1593	0.1590	55	0.5	—	0.0006
7†	0.1034	0.1027	43	0.5	—	0.0016
8	0.3505	0.3481	98	1.5	—	0.0024

¶ Consisting of butyl alcohol containing hydrogen chloride and a little perchloric acid

† Alcohol as received, not dried or distilled.

It is evident from the above data that the solubility of sodium chloride is greatly reduced by the presence of hydrogen chloride. That of lithium chloride is, however, much less affected. The addition of 4.9 per cent. of hydrogen chloride reduced it from 11.49 g. to 9.60 g. per 100 g. of solution. No lithium chloride was precipitated when a 20 per cent. solution of hydrogen chloride in butyl alcohol was added to a 40 per cent. solution of lithium perchlorate in the same solvent. The solubility of sodium chloride is reduced from 11.6 mg. per 100 cc. in pure, dry butyl alcohol to 1.4 mg. by the addition of 6 per cent. hydrogen chloride and to 0.6 mg. per 100 cc. by the further addition of 0.5 per cent. of 70 per cent. perchloric acid. The reason for this latter decrease is not evident. More than 0.5 per cent. of perchloric acid increases the solubility. In unpurified and undried 6 per cent. hydrogen chloride—alcohol containing 0.5 per cent. of perchloric acid, the solubility rises to 1.6 mg. per 100 cc.

Conditions Favouring Filtration. — The higher the temperature of precipitation, the greater the ease of filtration. From a boiling sodium perchlorate solution in butyl alcohol, the sodium chloride precipitated is perchlorate solution in butyl alcohol, the sodium chloride precipitated is coarse, settles rapidly, and filters easily. From the same solntion precipitated at room temperature, the precipitate is more gelatinous, settles slowly, and is difficult to filter and wash. The same solution precipitated at —15° to —20° cannot be filtered.

Since it is desirable to utilise cold precipitation to prevent occlusion of solvent by the sodium chloride, solutions precipitated at —15° to —20° were heated to boiling and allowed to cool to room temperature before filtration. The precipitate of sodium chloride should be formed by adding, drop by drop, to the cold solution, 1-1.5 cc. of the hydrogen chloride—butyl alcohol reagent, the remainder to form a 6 per cent. acid—butyl alcohol solution being added rapidly. Under these conditions the precipitated sodium chloride, after boiling, settles rapidly, and after cooling to room temperature can be filtered clear, using a Gooch crucible. It is washed with a 6-7 per cent. solution of acid in butyl alcohol. If the concentration of acid is over 6 per cent., coagulation of the sodium chloride is less effective.

Physical Constants of the Butyl Alcohol Used in the Method.—In view of the results obtained by Winkler[3] in the use of *iso*butyl alcohol, a rather carefully purified *n*-butyl alcohol was employed in most of the work recorded in this paper. Winkler used *iso*butyl alcohol dehydrated over caustic potash and which had a boiling range of one degree, 106-107°. It was further specified that this fraction of the dried sample was necessary for good results. It will be shown later that drying only and no fractionation is required.

Treatment of Filtrates from Sodium Chloride for Recovery of Lithium.—The filtrates from the sodium chloride precipitate consisted of a butyl alcohol solution of hydrogen chloride and perchloric acid, lithium and a slight amount of sodium as perchlorate or chloride, the latter resulting from the almost negligible solubility of sodium chloride. The salts were recovered by evaporation of the solvent and volatile acids, converted to lithium and sodium sulphates, ignited and weighed. From this weight, corrected for the known amount of sodium sulphate, the amount of lithium was calculated.

Although the dilute solution of anhydrous perchloric acid and lithium perchlorate could be boiled without trouble, evaporation to dryness without first adding water resulted in a violent deflagration; 30 to 50 cc. of water was added to 50-100 cc. of the cold alcoholic solution and 2 immiscible layers were obtained. The under layer of water extracted most, if not all, of the products of solution from the upper alcoholic layer. When this mixture was evaporated on a steam-bath the alcoholic layer evaporated completely, leaving the greater part of the water solution of lithium and sodium perchlorates and perchloric acid. The organic matter remaining was eventually oxidised, and after the addition of sulphuric acid the evaporation was continued to dryness. The lithium sulphate was then dissolved in a little water, washed into a weighed platinum crucible, covered and heated over a ring burner to remove excess of sulphuric acid. The conversion of lithium perchlorate to lithium sulphate is more easily carried out without loss than conversion of lithium chloride to sulphate. The lithium sulphate was ignited in a muffle at 600° for 5 to 10 minutes, or to constant weight in case of large amounts. Samples thus treated were neutral and could be fused without loss in weight.

SEPARATION OF SODIUM AND LITHIUM.

When free from potassium, the mixed chlorides (free from sulphate) obtained by the J. Lawrence Smith or other method, are evaporated to dryness with excess of perchloric acid. A second evaporation is desirable if the amount is large. If potassium is present it is first separated by the usual perchlorate method and the filtrate, *after addition of water, to avoid explosion*, is evaporated to dryness. Since a definite amount of perchloric acid should be present, it is desirable to remove first all excess of acid.

The mixed perchlorates of sodium and lithium free from perchloric acid are dissolved in anhydrous *n*-butyl alcohol using at least 15 g. or 18.5 cc. for each 100 mg. of sodium chloride present. The containing beakers may be conveniently weighed upon a small platform balance. The mixture dissolves readily if the alcohol is heated to boiling, which can be done with a burner over a wire gauze; 0.1 cc. of 70 per cent. perchloric acid is added and the solution is cooled to —15° by means of a freezing mixture. The sodium chloride is precipitated by adding from a buret, drop by drop, with constant stirring, 1-1.5 cc. of a 20 per cent. solution of hydrogen chloride in anhydrous butyl alcohol, after which the amount necessary to form a 6 per cent. solution is rapidly added (half as many cubic centimetres as there are grams in the solution to be precipitated). The precipitate of sodium chloride is then coagulated by heating the solution to boiling on a wire gauze with a free flame. After cooling to room temperature the sodium chloride is filtered on a weighed Gooch crucible and washed 8 or 10 times with a 6-7 per cent. solution of hydrogen chloride in butyl alcohol. (A rubber-tipped rod can be used in transferring the precipitate from beaker to crucible. It is well to preserve it by washing with a little acetone after use.) The sodium chloride is dried for one hour at 250° and ignited for 5 to 8 minutes at 600° in a muffle furnace (a free flame may be used but a very dull red must not be exceeded). A correction of 0.6 mg. for the sodium chloride remaining in each 100 cc. of filtrate and washings is added to the weight of sodium chloride found, to obtain the total sodium chloride present.

The filtrate and washings from the sodium chloride are diluted with one-third their volume of water (to avoid subsequent deflagration) forming 2 layers, and the whole is evaporated on the steam-bath in such a way as to avoid any condensation on the upper part of the beaker, which causes loss by "creeping." It is well to add 5 to 10 cc. of water at the end to make the removal of organic matter more complete before the perchloric acid takes effect. By such treatment a colourless residue of lithium perchlorate and perchloric acid can be obtained. If a slight brown colouration is present, remove the watch glass sup-

ports from the beaker and heat the covered beaker on a wire gauze to fumes of perchloric acid. If any brown colour remains adhering to the beaker walls after this treatment, it can be removed by brushing the walls o the beaker with the flame. If not enough perchloric acid is present to oxidise the last traces of organic matter, a few drops are to be added. When the brown colouration is removed, 0.5 cc. of conc. sulphuric acid is added, the watch glass replaced, and the acid fumed off, using either a hot plate or low flame and wire gauze. The beaker is then cooled, 5 to 10 cc. of water is added, and the cover glass and beaker walls washed. The lithium sulphate is then transferred to a platinum crucible previously ignited and weighed with its lid. The solution is cautiously evaporated to dryness and the covered crucible is heated, preferably by a ring burner, until every trace of acid is removed, after which it is heated to 600° in a muffle for 5 to 10 minutes. When the same treatment is carried out using a free flame and a very dull red heat, some reduction to sulphide often takes place, due to diffusion of the flame gases through the platinum. Fusing with a free flame to check the weight obtained by the above treatment is possible if the temperature is not too high or the treatment too long.

The weight of lithium sulphate is to be corrected for its sodium sulphate content by subtracting the weight of the solubility correction calculated as sodium sulphate, or 0.7 mg. per 100 cc. of filtrate and washings. A further correction to be applied is a blank for the reagents employed. This correction is found by precipitating a weighed sample of sodium chloride in the manner above described. One cc. of perchloric acid is ample for any ordinary quantity of salts to be converted, and the subsequent additions of 0.5 cc. each of sulphuric acid and perchloric acid are enough to provide excess. The weight of material obtained at the end of this process should be less than 1 mg. when corrected for the sodium chloride solubility.

Gooch crucibles with 0.5 mm. holes are much better than those with large holes. Platinum Gooch crucibles with their much smaller perforations are still better. A heavy mat of asbestos is essential, and a perforated porcelain disc should be placed on it to prevent disturbance of the mat. If platinum-sponge filtering crucibles are used, weighing of the empty crucible should be made after the sodium chloride has been washed out with water, since spongy platinum is slightly attacked. Asbestos for use in filtrations with solutions of hydrogen chloride in butyl alcohol should be refluxed with some of this material in preparation for its use. The same crucible should be used many times over, and in such a case previous treatment of the asbestos with the acid-alcohol solution is not necessary. To show the effect of the solvent upon asbestos, the same crucible was used repeatedly, starting with untreated asbestos. The sodium chloride was washed out each time. The following successive weights were obtained: 26.6413, 26.6405, 26.6401, 26.6401, 26.6401. In order to avoid an additional operation the filtration with suction can be made directly from the crucible to a beaker by using a vacuum desiccator of the usual form but with a hole provided in the cover for the passage of a filtering tube and rubber stopper. In this way the beaker to receive the filtrate can be placed in the bottom of the desiccator. The filtering tube should have a small perforation in its side about an inch from the bottom to prevent spattering.

The filtrates were rapidly evaporated on the steam-bath by immersing the beaker in a copper capsule flanged at the top and fitted to the rings of the steam-bath so that condensation did not take place on the walls of the beaker or cover glass. This is very important because the alcoholic solution shows a strong tendency to "creep."

The value of the method was tested by a series of analyses of known mixtures, with the results recorded in the following table.

TABLE IV.

Separation and Estimation of Sodium and Lithium.

Expt.	NaCl taken G.	NaCl found G.	Error G.	$LiClO_4$ taken G.	LiCl calc. G.	Li_2SO_4 found G.	LiCl found G.	Error G.
1	0.1521	0.1519	-0.0002	0.4819	0.1920	0.2498	0.1919	-0.0001
2	0.1481	0.1478	-0.0003	...	...	...	...	...
3	0.1017	0.1017_0	0.0000	0.5534	0.2205	0.2860	0.2206	+0.0001
4	0.2027	0.2024	-0.0003	0.5295	0.2110	0.2736	0.2110	0.0000
5	0.1016	0.1016	0.0000	0.3004	0.1197	0.1558	0.1202	+0.0005

§ Alcohol dried but not fractionated; boiling range 112-118°.

The separation of sodium from very large amounts of lithium is accomplished by one precipitation (Expt. 7).

In case it is desired to avoid a cold precipitation (a step which requires but one short additional operation), the method can be applied exactly as described, omitting cooling to −15° before precipitation, and adding the precipitant to the mixed perchlorate solution at nearly its boiling temperature. *In this case the solubility of sodium chloride* was found to be 1.6 mg. in 100 cc. of solvent. The carbon occluded by a precipitate of about 0.5 g. of sodium *chloride is approximately* 1.5-1.0 *mg. under* these conditions. The weight of sodium chloride in the precipitate can be determined by dissolving it in water, drying the crucible with its *carbon impurity*, and weighing after filtration rather than before.

SUMMARY.

1. A method is described for the separation of sodium and lithium based upon the *precipitation* of sodium chloride from a solution of the perchlorates in anhydrous *n*-butyl alcohol by the addition of an alcoholic solution of hydrogen chloride.

2. Conditions affecting the accuracy of the process were studied and the accompanying errors eliminated.

3. The solubilities of the anhydrous per*chlorates and chlorides of lithium and so*dium in anhydrous *n*-butyl alcohol at 25° are given.

4. A table is given showing the density *and composition of solutions of hydrogen* chloride in butyl alcohol.

5. Test analyses show that one separa-
convegives accurate results even in the pre-
The lith! large amounts of lithium.
muffle at 600° for a ...
constant weight in case ord *Urbana*,
Samples thus treated were .
could be fused without loss in wec American
. SEPARATION OF SODIUM AND Li2.)
When free from potassium, th
chlorides (free from sulphate) obtai
the J. Lawrence Smith or other r
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desirable if the amount is large. Iards Asso-
sium is present it is first separatedal of Brit-
usual perchlorate method and the1917, from
after addition of water, to avoid exnow under
is evaporated to dryness. Since a the follow-
... of perchloric acid should be issued as

(a) Industrial machines (B.S.S. 168-1923) has already been published, whilst (b) Large machines, (c) Transformers, (d) Rotary Converters, and (e) Traction motors are in course of preparation.—*(From the "Board of Trade Journal," July* 12, 1923.)

CONDENSED MILK INVESTIGATION.

The Food Investigation Board of the Department of Scientific *and Industrial* Research has issued Special Report No. 13., under the title of "Studies in Sweetened and Unsweetened (Evaporated) Condensed Milk," by W. G. Savage, M.D., B.Sc., and R. F. Hunwicke, B.Sc., A.I.C.

The Report has been prepared by the Canned Foods Committee of the Food Investigation Board, and deals chiefly with *the bacteriological* problems involved in the successful condensation and canning of milk.—*(From the "Board of Trade Journal," July 12, 1923.)*

CANADIAN NATIONAL EXHIBITION.

In a recent dispatch, H.M. Trade Commissioner at Toronto reports optimistically of the probable British participation in the Canadian National Exhibition, to be held in that city from August 25 to September 8 next.

The British displays may be classified under three headings:—

(i) Private exhibits, which are far more numerous this year than previously.

(ii) The collective exhibit organised by the Federation of British Industries, which is understood to have been wel supported.

(iii) The Propaganda and Sample Bureau, maintained for the Departmen of Overseas Trade by H.M. Trade Com missioner, on which firms will displa trade catalogues and table samples. I is understood that at least 40 Britis firms will avail themselves of the oppo tunity offered by this Bureau.

In connection with the rapid growth the Canadian National Exhibition, it is r ported that the Cuban Government is co sidering a recommendation to vote a su of 50,000 dols. for the erection of a perm nent *pavilion to house* an annual Cub exhibit at Toronto.—*(From the "Board Trade Journal," July 12, 1923.)*

In the House of Commons, recently, Mr. Attlee asked the President of the Board of Trade whether he was aware that the British Dyestuffs Corporation, Limited, charged 10 per cent. commission on reparation dyestuffs, whereas, when the distribution was undertaken by the central importing agency, only 2½ per cent. was charged; and for what reason was this high rate of commission permitted?

Sir P. Lloyd-Greame replied: I am not aware that the British Dyestuffs Corporation charge 10 per cent. commission on reparation dyestuffs, and would refer to an answer which I gave on this matter on December 4 last, to the effect that the Corporation receives a commission of 6½ per cent. on the actual turnover plus a further 1 per cent. for guaranteeing accounts, and a grant, which is limited in amount, towards the charges which they incur relating to the importation of the dyestuffs. The Central Importing Agency undertook the duty of importing and distributing the dyestuffs for a commission of 3½ per cent., the rate to be adjusted if prices fell, but this charge proved to be inadequate, and was considerably increased with the approval of the Treasury by various allowances made to the Central Importing Agency upon the final adjustment of their accounts.

Mr. Attlee further asked the President of the Board of Trade whether he was aware of the high prices charged for reparation dyestuffs by the British Dyestuffs Corporation, Limited; that the price of diamine fast yellow F.F., a dye for which there was no satisfactory British substitute, had been raised from 4s. per lb. to 7s. 6d. per lb., and to 10s. per lb., although this dye could be imported from Germany for 4s. 6d. per lb.; and of the discontent aroused by this action among colour users; and what action he was prepared to take in the matter?

Sir P. Lloyd-Greame said: No complaint about the price of this dyestuff has been received by the Board of Trade, but the arrangements as to the pricing of reparation dyes are being reconsidered, and the price of this particular dye will come under review.

Major-General Sir Robert Hutchinson asked the President of the Board of Trade whether he was aware that British importers of lithopone from Germany who made contracts before February 1 found it almost impossible to get delivery of their goods, because the French authorities would not issue export licences, even after the payment of the French 7 per cent. duty, and that although the French authorities, under pressure, agreed to issue export licences, they, in fact, put every obstacle in the way of British traders receiving these licences; and what could he do in the matter to protect British trade interests?

Sir P. Lloyd-Greame said: The answer to the first part of the question is in the negative. If the hon. and gallant member will furnish me with particulars of the cases which he has in mind I will make inquiry.

CORRESPONDENCE.

THE COLOURING OF POISONS.

To the Editors of THE CHEMICAL NEWS.

SIR,—In the interests of public safety, it will be unfortunate if a recent decision of the General Medical Council be accepted as the final word in the highly important question of colouring deadly poisons. The facts are simple. After careful experimenting by British dyemakers and pharmacists, the Pharmaceutical Society of Great Britain recommended Brilliant Green to the Privy Council as a colouring for a preparation of strychnine. The Privy Council forwarded the suggestion to the General Medical Council as the body who could say whether Brilliant Green would interfere with the healing properties of the strychnine preparation in question. Thereupon the General Medical Council unanimously condemned the proposal, and that for six reasons, only two of which can be said to have a remote connection with the curative aspect of the question, namely, that, in certain mixtures, Brilliant Green undergoes colour changes which "might be objectionable" to patients, and that a coloured solution "would be objectionable" for hypodermic injection.

The four other points made were: (1) *that it was only proposed to colour one* strychnine preparation; (2) that risk would arise from keeping coloured solutions side by side with uncoloured; (3) that, the preparation being uncoloured in other countries, difficulties of an international kind would arise; and (4) that the question was a general one and should not be determined in the case of a single preparation of a single poison.

These four objections may be just or they may not. *What I do submit is that they are matters of policy to be determined by* Parliament in open debate rather than *settled autocratically by the most conservative* of our trade unions.—Yours, &c.,

JAMES SEXTON.

House of Commons, S.W.1.
July 16, 1923.

NOTICES OF BOOKS.

Quantitative Chemical Analysis and Inorganic Preparations, by R. M. CAVEN, D.Sc. (LOND.), F.I.C. Part I. Pp. VI. + 156. London: Blackie & Sons, Ltd., 50, Old Bailey, E.C. 1923. 3s. 6d. net.

The author has aimed at including in one volume *all the essential practical exercises* that a student should carry out. He has not included any superfluous matter—at least in the first part now under review.

Part I. includes a description of the preparation of certain typical salts and their *gravimetric* analysis, followed by exercises in volumetric analysis. It is intended that Part II. will contain a more extensive selection of preparations.

In general, the book follows the lines that have been found most suitable in presenting the subject to students. It possesses, however, one or two features that call for special mention. The introductory instructions are particularly well presented, and it is to be hoped that all students using the book will master them at the beginning of the course.

Another point of interest is the use of standard oxalic acid as the basis of standardisation in acidimetry and alkalimetry. By following this procedure, the teacher has a good opportunity to press home a number of interesting theoretical and practical points. It might be pointed out here that the short note on the Use and Theory of Indicators does not go very far and seems *inadequate*.

Also, whilst most of the matter in the section on preparations is good, the method suggested for ferrous ammonium sulphate could be much improved.

The book, as a whole, fulfils its intention for the use of students who have passed the elementary stage, and it will prepare such [illegible], in practical work, up to degree amount

LITERARY INTELLIGENCE.

Volume II., Part II. of Molinari's "*Organic Chemistry*" *will shortly be ready*. This volume completes the whole section of the work, thus making available a comprehensive *treatise covering the whole ground* of Industrial Chemistry, both Inorganic and Organic.

The *new part* contains over 300 illustrations, and deals with the subjects of Esters, Oils and Fats, Sugars and other Carbohydrates, Cyclic Compounds, Dyestuffs, Textile Fibres, Proteins, etc.

The publishers are Messrs. J. & A. Churchill.

New Patents.

THIS list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

17681—Finch, G. I.—Process for recovering ammonia from gases or vapours. July 7.

17130—Lilienfeld, L.—Manufacture of cellulose solutions. July 2.

17466—Soc. Chimique des Usines du Rhone.—Preparation of diethylchloracetamide. July 5.

17388 Soc. of Chemical Industry in Basle.—*Manufacture of alkaline-earth metal compounds of the organic phosphorus compound in milk casin.* July 4.

Specifications Published this Week.

173750—Brynes, C. P.—Partial combustion *methods for treating aliphatic hydrocarbons.*

199475—Lessing, Dr. R.—*Manufacture of neutral* sulphate of ammonia.

199607—Westermann, J. T.—Process for manufacturing pure sodium chloride.

181388—Chemische Fabrik Griesheim Elektron.—Process of the production of basic magnesium carbonate.

Abstract Published this Week.

197863—Phosphorus pentoxide.—Threlfall, Sir B., of Oakhurst, Church Road, Edgbaston, Birmingham.

Phosphorus pentoxide made by burning phosphorus in a stream of dry air is condensed at a temperature of 125 to 200° C. in a compact, crystalline form. To avoid the presence of a small amount of the amorphous, bulky variety a portion of the vapour at about 160° C. is led through a filter containing glass wool to a second condensing chamber.

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THE CHEMICAL NEWS,

VOL. CXXVII. No. 3303.

X-RAY SPECTROSCOPY AS A MEANS OF QUALITATIVE AND QUANTITATIVE CHEMICAL ANALYSIS.

By D. Coster.

The X-ray emission from the anticathode of an X-ray tube consists of two essentially different parts: (1) The heterogeneous radiation, or the "white" X-ray light, the nature of which depends only on the tension used and not on the material of the anticathode; (2) The characteristic radiation, or the "line spectrum," which characterises the elements present on the anticathode. The X-ray line spectra have a much simpler structure than the optical line spectra. The characteristic X-ray spectra of the different elements are built up in nearly the same way, which is due to the great similarity of the inner groups of electrons of the atom for the different elements. They consist of but very few strong lines and a relatively small number of weaker lines. For the X-ray lines the following simple relation holds: the square root of the frequency of a definite line is to a first approximation proportional to the atomic number of the emitting element. Roughly speaking, we could say: If the X-ray spectrum of a definite element is known, those for the next elements with higher atomic number are found by shifting the whole group of lines a certain amount to the short wave-length side. This fact may be illustrated by the following figures.

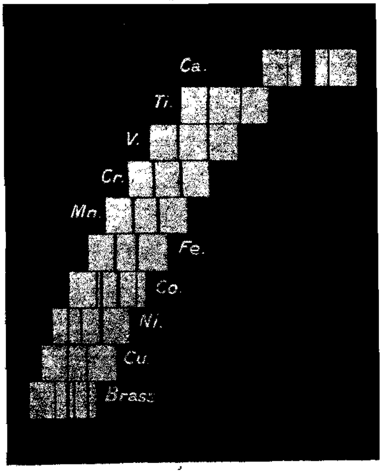

Fig. 1.

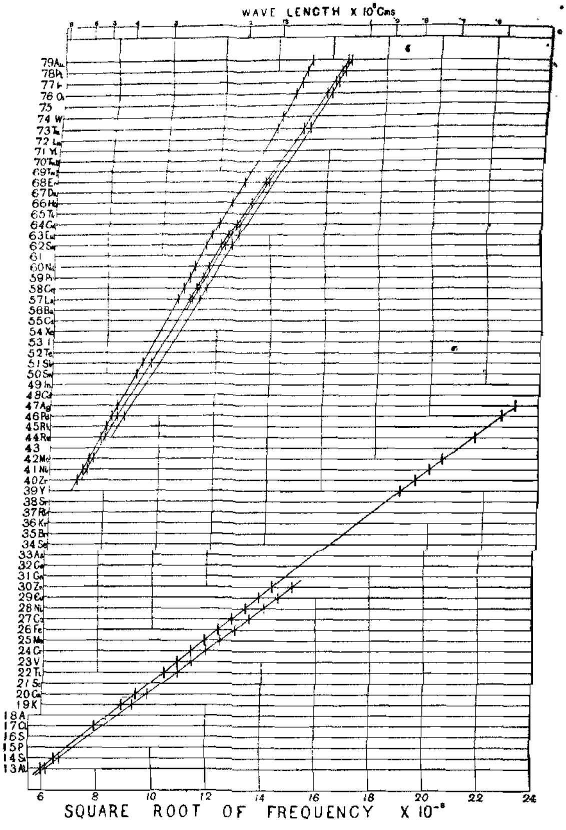
WAVE LENGTH X 10^8 Cms
6 8 10 12 14 16 18 20 22 24
SQUARE ROOT OF FREQUENCY X 10^-8

Fig. 2.

Fig. 2 gives the square roots of the frequences of some lines of the K-series (ordinates) as a function of the atomic number (abscissæ). Fig. 1 gives the photographs of the lines for the same series for some lighter elements (both figures have been taken from a paper by Moseley[1]). As appears from the above, the atomic number of an element is strictly determined by its X-ray spectrum. As we know, Moseley, in his fundamental investigations of the high frequency spectra, was able to determine in this way the number of elements between Ba and Ta. Whereas, in consequence of the exceptional behaviour of the rare earth metals, no direct information in this matter could be obtained from Mendelejeff's table.

Due especially to the work done in the laboratory of Prof. Siegbahn, the X-ray spectra of the elements Na-U are known rather completely. Following Barkla's nomenclature of the characteristic X-radiation the lines have been classified in different groups or series which are called K-, L-, M-, and N-series. The range of wave-lengths which can be measured in the present state of X-ray spectroscopy lies between 13.5 and 0.1 A-units. As a consequence of this, the K-series of the lighter elements could only be measured as far down as Na, the L-series is only known for the elements of higher atomic number than Co, whereas the M-series, as yet, has been found only for the elements of higher atomic number than Dy, and the N-series only for Bi, Th, and U.[2]

As a chemical element is unambiguously determined by its X-ray spectrum, X-ray spectroscopy may be used as well as optical spectroscopy, as a means of identification of elements. For this purpose the former has even some important advantages: (1) As the X-ray spectra are much simpler than the optical spectra, the identification of the lines meets with less difficulties; (2) In X-ray spectroscopy it is of no importance in what mixtures or compounds the element in question occurs; (3) One per cent. of a certain element, in a preparation of which only 1 milligram is available, is enough to be detected.[3]

It may be pointed out, however, that in general some faint X-ray lines do not suffice to determine a certain element, even if their position nearly coincides with that expected for the element in question. Though, as is stated above, the number of X-ray lines is very limited, in the last few years several investigators have succeeded in establishing the existence of a rather large number of fainter lines. Moreover, as usually rather high tensions are used, not only the spectrum of first order, but also that of second and third, and in some cases even of still higher order may appear.[4] As also very small impurities of the anticathode material and of the substance under examination give their characteristic X-ray spectrum, in most cases there are several possibilities for the identification of a given line. In order to avoid erroneous conclusions, regard must therefore be taken not only to the wave-lengths of the lines, but also to their typical behaviour, especially as regards the relative intensity of the lines belonging to the same element.

In one respect, however, X-ray spectroscopy might be of more use for chemistry than optical spectroscopy, in that it may also be applied successfully to *quantitative* analysis. It was used for the first time for this purpose by Hevesy and the author

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[1] *Phil. Mag.*, 1913, XXVI., 1024; 1914, XXVII., 703. *Though in Fig.* 1 *the nomenclature of the elements* 69-72 *is not wholly up-to-date, I thought it of great historical interest to reproduce the figures as they are found in the original papers.*

[2] *See M. Siegbahn. Jahrbuch für Radioaktivität*, 1922, XVIII., 240. *Publications of later date which are not mentioned in Siegbahn's summarising article are*: *M. Siegbahn and V. Dolejsek, Zeitschrift für Physik*, 1922, X., 159; *D. Coster, Phil. Mag.*, 1922, XLIII., 1070 *and* 1922, XLIV., 546; *Hjalmar, Zeitschrift für Physik*, 1923, XV., 65.

[3] *Methods and apparatus have been thoroughly discussed by M. Siegbahn Jahrbuch der Radioaktivität*, 1916, XIII., 296, *and* 1922, XVIII., 240.

[4] *According to Bragg's relation*: $n\lambda = 2d\text{-}\sin$ *(here is the glancing angle, d the grating constant,* λ *the reflected wave-length, and n an integer) corresponding to different values of n different values of* λ *are related to a definite glancing angle.* $n = 1$ *corresponds to the first order spectrum,* $n = 2$ *to the second order spectrum, etc. How far the spectra of higher order appear depends on the tension used and the analysing crystal.*

during an examination of the occurrence of *the new element* hafnium[5] in zirconium minerals and the investigation of its chemical properties. The main *feature of the* method is the addition to the substance to be examined *of a known quantity of an element* with an atomic number in the neighbourhood of that of the element under consideration and the determination of the X-ray spectrum *of the mixture.* By comparison of the intensity of the lines of the added element to that of the corresponding *lines of the element* under investigation an estimation of the concentration of the latter element may be obtained. The reliability *of the method appears* from the following *considerations.* The energy of an X-ray *line is proportional* to the number of atoms *of the corresponding element* in the anticathode *spot. In the case of two elements adjacent in the periodic table, the configuration* of the inner electrons of the atom is very nearly the same. We may, therefore, assume that the ratio of the energies of two corresponding lines of such elements in first approximation is the same as that of the numbers of radiating atoms belonging to each of them.

Two objections could be raised against the method. (1) The critical exciting tension *of a definite* line is not the same for different elements. Using a tension which is much higher than the critical tension of the lines for the elements in question, this *difference may be neglected*[6]. (2) Another objection could be made against the *practical application* of the method. By *sputtering or evaporation, part* of the atoms present in the anticathode spot will disappear *during the course of an exposure. In general* this will give rise to a change in the *ratio of the quantities of the different elements* present on the anticathode. Errors *due to this circumstance,* however, may be avoided by a suitable choice of the conditions of experiment (small current densities in the anticathode spot). Only in a few exceptional cases, *e.g.,* if mercury or iodium *compounds* are to be investigated, the method would not lead to the right results.

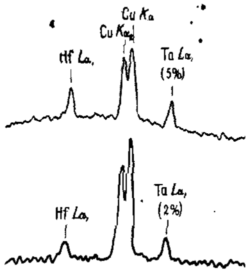

Fig. 3.

Figure 3 shows how the hafnium content in zirconium minerals was determined. The figure represents a photometer curve of the blackening of the photographic plate taken with the Moll *microphotometer*[7] of the firm Kipp (Delft, Holland). The uppermost curve is taken from a plate of a zirconium *mineral from the Ural.* The hafnium content appears to be a little more than 5 per cent. The copper lines are due to the copper anticathode. The zirconium Kα lines which in second order lie nearly on the same place as the hafnium Lα lines, could not appear on the plate, as the tension used during the exposure was less than the critical tension for the zirconium lines, *i.e.,* 18,000 volts. The other curve represents the blackening of a photograph of a *zirconium mineral from Brazil.* The hafnium content appears to be a little smaller than 2 per cent.

In the same way the chemical properties of hafnium were studied. Our former investigations *had* already shown that in nearly all zirconium minerals a rather large percentage of hafnium is present. From *this we might conclude that the chemcial* properties of hafnium are closely related to those of zirconium. This conclusion was firmly established by a further investigation. The method used may be illustrated in the following example. In order to determine the solubility of hafnium phos-

[5] *Nature, Feb.* 10, 1923. *See also G. Hevesy, The Chemical News.*

[6] *In this connection it may be pointed out that the intensity of the characteristic X-ray spectrum is in first approximation proportional to the second power of the difference of the tension used and the critical tension.*

[7] *W. J. H. Moll, Proceedings Phys. Soc. London,* 1921, XXXIII., 207.

phate compared with that of zirconium phosphate, a solution of a mixture of zirconium and hafnium was precipitated with sodium phosphate in 11 equal fractions. The original mixture contained about 4 per cent hafnium; 10 per cent Ta was added to each of the different fractions, and then the X-ray spectra were investigated. Figure

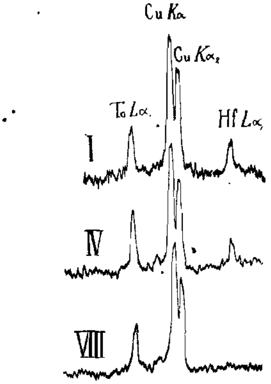

Fig. 4.

4 gives the photometer curves of the spectra of the 1st, 4th, and 8th fraction. These curves clearly show that the solubility of hafnium phosphate is considerably less than even that of zirconium phosphate.

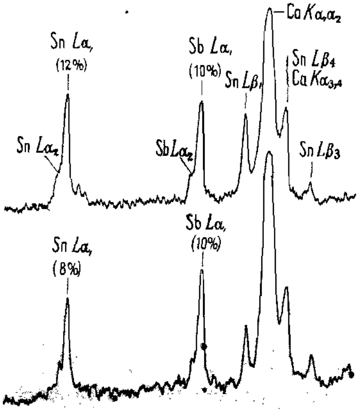

Fig. 5 gives an idea of the sensibility of the method. Two artificial preparations were made of $CaSO_4$ mixed with $SnCl_2$ and Sb_2O_3. Both preparations contained 10 per cent. antimony. To the first 12 per cent. tin was added, to the other 8 per cent. The photometer curves express very well the real state of things. It may be pointed out that the above example was not at all chosen so that it should give a too favourable impression of the reliability of the method. Indeed, antimony oxide sublimates very soon, and when the preparation was heated in the Bunsen flame before the exposure, the antimony appeared to have decreased by about 30 per cent. relatively to the amount of tin. Therefore, in exposing the plates, a rather small current was used and the anticathode was cooled effectively.

Evidently it is possible to improve the sensibility of the method. We will discuss some sources of error which were to be taken into consideration for obtaining a larger accuracy. (1) The photographic plate has not the same sensibility at different places. Errors of this origin could be avoided by determining the photometer curves at different heights of the plate and eventually by taking more than one plate of the same preparation. (2) The different lines appearing on the photographic plate are reflected by different parts of the crystal and in general the reflecting power of the crystal will not be the same at different places. (3) The different lines correspond to different parts of the anticathode spot for which in general the intensity of radiation will not be the same. The last two errors could be avoided for the greater part by constructing the apparatus in such a way that only a very small angle was exposed at the same time. In this case only a definite part of the crystal is used, the radiation coming from a definite part of the anticathode spot. As it is necessary to photograph more than one line on the same plate the crystal was to be turned during the exposure.

In order to obtain a greater accuracy it would also be desirable to make the amount of the comparison element as exactly as possible equal to that of the investigated element, which, of course, can only be done by repeated trials. In proceeding in this way, however, we should miss one of the greatest advantages of X-ray analysis, *i.e.*, *its rapidity. Therefore in this form it* should only come into consideration for elements like zirconium and hafnium, for which quantitative analysis meets with great difficulties. But if a great accuracy is

not wanted in the first place, *e.g.*, in the case of investigations of minerals, the method as it was used in our hafnium investigation works very quickly, having at the same time a high reliability. In this connection it may be pointed out that it is not at all necessary to take photometer curves of all the plates. After some experience, it is not difficult to estimate rather accurately the relative intensity of lines with the eye. Moreover a relatively small difference in the blackening of the lines reveals itself clearly as a phase-difference in the appearance of the lines during the development of the plate.

As is shown above, X-ray analysis gives a means of rapid determination of the nature and the amount of the elements occurring in a preparation. It may, however, also be used in an investigation of the physical and chemical state of these elements. The method described above is founded on the analysis of the characteristic X-ray spectrum of the investigated element by reflection on a crystal plane of a crystal with known space grating constant, *e.g.*, calcite, rocksalt or gypsum. But we can conversely also try to determine the crystal structure of our preparation with the aid of monochromatic X-ray light of known wave-length. About this side of X-ray analysis I will only make some remarks which could be of interest in connection with the above. Ordinary qualitative analysis is able to inform us that a certain preparation contains, *e.g.*, calcium and potassium and a chloride and a nitrate, but this analysis does not directly give the further information as to whether we have a mixture of calcium nitrate and potassium chloride, or of calcium chloride and potassium nitrate. An examination of the crystal structure, however, will throw light upon this question also. For this purpose the most adequate method is the "pulverised crystal method."[8] Naturally it is not possible to use a diagram of a crystal mixture for calculating the different crystal structures which are present in the mixture, but this is not necessary. The only thing we want is a collection of standard diagrams of the crystal structures which may be supposed to be present in the mixture. By a comparison of the diagram of the mixture and the standard diagrams it is easy to see which crystals are present and which not. In this way Dr. A. Hadding, of Lund—as he kindly told me—has used X-ray analysis to determine the components of dense mineral ores and other mineral aggregates.

[8] *P. Debye and Scherrer, Phys. Zs.*, 1916, XVII., 277; *A. W. Hull, Phys. Review*, 1917, X., 661.

ORGANIC COMPOUNDS OF ARSENIC.

PART I.

By R. F. Hunter, F.C.S.

The organic compounds of arsenic are some of the most interesting and valuable substances, both from the point of view of academic interest and from that of therapeutic value, and hence a brief survey of our knowledge might be given.

The subject carries us back to the year 1760, when Cadet produced his "fuming liquid" by the distillation of arsenious acid with sodium acetate in equal proportions by weight: Two liquids appeared in the receiver used in the distillation, the more volatile compound exhibited acid properties while the less volatile compound was a red-brown liquid which filled the receiver with fumes. Both components had a most sickening odour, resembling to some degree the odour of garlick. The heavier of the two liquids, that is to say, the red-brown compound exhibited spontaneous inflammability when an attempt was made to pour it from the receiver at ordinary temperature. Madet and Durande, who subsequently investigated the reaction, showed the heavy liquid to possess the viler stench and to be the component possessing spontaneous inflammability.

The most sickening foetid odour of the compound deterred investigators from the subject for nearly eighty years. This is not so surprising when we consider the lack of means for experiment of the time, coupled with the stupefying odour which produced nausea and unbearable irritation of the nasal mucous membrane, which the compound possessed.

In the years 1837-1843, Bunsen carried out his classical researches on this compound. The preparation was repeated on a large scale, 500 gms. of both constituents being distilled together:

Analysis gave the formula $C_4H_{12}As_2O$, and Bunsen showed the compound to be tetra-methyldiarsine oxide,

$(CH_3)_2 As O As (CH_3)_2$,
and the reaction to be our usual test for an acetate in minute quantities, viz.:—

$As_2O_3 + 4CH_3COONa = (AsMe_2)_2O + 2Na_2 CO_3 + 2CO_2$.

The free radical cacodyl or dimethylarsene was subsequently isolated by the action of zinc clippings on the chloride of cacodyl, the reaction carried out in an atmosphere of CO_2. This is only a brief historical survey, and the complete accounts can be found in the references at the end of the article.

Aliphatic arsenicals, such as methylarsines, etc., have been prepared by the usual methods given in text books of organic chemistry, viz., such reactions as the action of zinc alkyls on arsenious chloride, alkyl halides on sodium arsenide, etc.

Examples:—

$2 As Cl_3 + 3ZnMe_2 = 2AsMe_3 + 3ZnCl_2$.

$As Na_3 + 3CH_3I = AsMe_3 + 3NaI$.

The compounds of several series of this type have been studied, for instance. Ethylarsines, Propyl, Allyl, and Butyl, and amyl arsines and their derivatives have been described by various workers.

The aromatic compounds are of more interest to us, however, from the point of view of their closer relationship to the important medicinal compounds of arsenic such as salvarsan, etc., which are of great importance in the treatment of protozoal diseases.

As far back as 1863 Bechamp found that arsenic could react with aniline without oxidation of the base, he obtained apart from his other products, such as dyes of magenta type. A compound,

$C_6H_4NHAs(OH)_2$.

It is remarkable that only within the last ten years or so have we come to regard the acid as having the constitution which was assigned to it by its discoverer.

The sodium salt was introduced into medicine under the name of "atoxyl," which was much used at one time as a cure for sleeping sickness. The compound was used in the form of intravenous injections. It was a compound remarkably fatal to the trypanosones of sleeping sickness, but suffered from the dsiadvantage that the patient very often exhibited symptoms of arsenical poisoning after such an injection, the poisonous effects being cumulative such that they could finally give rise to complete blindness and kidney complications.

Hosts of researchers in the field of aromatic arsenicals have produced a large number of compounds of varying importance.

The classes of compounds produced might have been divided as follows:—

(1) Benzene derivation with one aromatic nucleis attached to one arsenic atom.

Examples: Phenylarsenious chloride, $C_2H_6 - AsCl_2$, compounds, such as the methyl ethyl phenyl esters of phenylarsenious acid:

Phenylarsenic acid, $C_6H_5AsO(OH)_2$, its salts, esters and halogen derivatives, but

Arsenobenzene, $C_6H_5As As C_6H_5$, is the most interesting compound of this class owing to its relation to salvarsan.

(2) Benzene derivatives with two aromatic nuclei attached to one arsenic atom, examples of which are diphenylarsenious chloride, phenylcacodyl, $(C_6H_5)_2 As As (C_6H_5)_2$, diphenylarsine and its derivatives.

(3) Benzene derivatives with three aromatic nuclei attached to one arsenic atom. Triphenylarsine, Ph_3As, is simplest example.

(4) Toluene derivatives with one aromatic nucleus attached to one arsenic atom.

Examples of this are o-Tolyarsenious chloride, o-Tolylarsenious oxide, o-tolylarsenious acid, and the corresponding m and p compounds.

We have also mixed tertiary arsenic with a tolyl radical, an example of which is p-tolydimethyl arsine.

(5) Toluene derivatives with two or three aromatic nuclei attached to one arsenic atom.

These we further sub-divide into triaryl and diaryl series, examples heing tri-p-tolyarsine and Di-p-tolyarsenious chloride.

(6) Benzyl derivatives, of which tribenzylarsine, $As(CH_2C_6H_5)_3$, is an example.

(7) Aromatic arsenicals containing higher aryl groups: Compounds such as m-xylylarsenious chloride; oxide, sulphate, etc., are examples.

(8) Arsenical derivatives of naphthalene; these are of peculiar interest, and examples are: α-Naphthylarsenious Chloride, $C_{10}H_7$-AsC_2;

Arsenic α-naphthalene, $C_{10}H_7As As C_{10}H_7$;

α-Naphthylarsenic acid, $C_{10}H_7As O (OH)_2$;

β-Naphthylarsenic acid, $C_{10}H_7As O (OH)_2$.

(9) Benzarsenic acids and derivatives which are further sub-divided into:

(*a*) Toluene series.

(*b*) Xylene series.

(*c*) Pseudo cumene series.

p-Benzarsenic acid,

$CO_2HC_6H_4AS\ O\ (OH)_2$,

is an example of the first, and phenylditolylarsineoxidecarboxylic acid, triphenylarsineoxidetetracarboxylic acid, are examples of the second, and phenyldixylylarsineoxidedicarboxylic acid and phenylditolylarseneoxidetetracarboxylic acids are examples of the third.

(10) Betaines of Aromatic Arsenicals. *Phenyldiethylarsenicbetainehydrochloride*, and triethylarsenibenzobetaine are good examples.

(11) Nitro derivatives of aromatic arsenicals, compounds such as m-nitrophenylarsenic acid, m-nitrophenylarsenicals, brofide sulphides, sesquisulphide, dinitrodiphenylarsenious sulphide, chloride, etc., are examples.

Of particular interest in the group are the reduction products of 3-nitro-tolyarsenic acid:

3:3 dinitro arsenic p-toluene.
3-nitro-4-tolyarsenious sulphide.
3-amine-4-tolylthioarsinic acid, etc.

We have now to consider the two classes, compounds which are of immense importance in medicine, and which will be dealt with under the titles of Atoxyl and its derivatives, Salvarsan and its derivatives.

RELATIVE DETERMINATION OF THE ATOMIC WEIGHT OF CHLORINE IN BAMLE APATITE.

By Margot Dorenfeldt.

Introduction.

This work was undertaken at the suggestion of Dr. Ellen Gleditsch in connection with an investigation carried out by Gleditsch and Samdahl,[1] the object being to determine whether, in an old mineral which has not been in contact with water, the two chlorine isotopes of atomic weights 35 and 37 occur in the same proportion as in ordinary chlorine. The mode of attack was to compare the specific gravities of saturated solutions of sodium chloride, one solution being made from ordinary sodium chloride and the other from Bamle apatite, the method being similar to that described by Fajans and Lembert.[2]

Apparatus and Materials.

The pycnometer was an exact copy of one described by Fajans and Lembert,[2] a modified Sprengel-Ostwald type. The temperature variations of the thermostat cannot be given accurately, but a 0.1° thermometer showed no change. The glass test-tubes in which the solutions were rotated in the thermostat were of thick glass, 14 cm. long, and of 22 mm. internal diameter. The clean tubes and the rubber stoppers were soaked in warm brine solution for 12 hours, after which treatment they were carefully rinsed. The balance was a Bünge with a sensitiveness of 0.4 mg.; no mirror was used, but ¼ divisions could easily be read.

The "ordinary sodium chloride" was a commercial highly purified preparation which was further purified. A saturated solution was treated with chlorine, the excess chlorine removed by boiling, the salt precipitated with hydrogen chloride, recrystallised several times, ignited, and then recrystallised several more times. All final crystallisations were made in platinum with twice-distilled water, the second time from alkaline permanganate.

The apatite was from the Odegaarden mines in Bamle, and was comparatively rich in chlorine, but the presence of considerable fluorine made it difficult to obtain a preparation free from silica. It was heated with 70 per cent. c.p. sulphuric acid and the acid distillate of hydrochloric, hydrofluoric and sulphuric acids and silicon tetrafluoride was neutralised with a highly purified commercial sodium carbonate. The precipitated silica was removed, and after 3 crystallisations the salt was divided into 2 portions, from 1 of which was made a saturated brine solution and from the other was generated a stream of hydrogen chloride which was brought to the surface of the brine solution. The precipitate, dried by suction, was heated to redness in platinum, dissolved, filtered, recrystallised 7 times, ignited again, dissolved and filtered, and then recrystallised 5 times.

Specific-Gravity Determinations of the Saturated Solutions.

The two salt solutions, one from ordinary sodium chloride, the other from apatite, were evaporated until crystallisation began. The warm solutions were transferred to the tubes, and when cool, the tubes were tightly closed with rubber stoppers.

After 3 days' rotation the first weighings of the filled pycnometer were made, No. 1 in the table below. The "apatite sodium

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[1] *Gleditsch and Samdahl, Compt. rend.*, 1922, CLXXIV., 746. *Arch. Math. Naturvidensk.*, 1923. XXXVIII.

[2] *Fajans and Lembert, Z. anorg. Chem.*, 1916, XCV., 297.

chloride" solution was slightly cloudy, the numerous recurring opalescence must have been due to traces of fluoride. Baryta water was added, whereupon a distinct turbidity appeared, and the solution was filtered. The excess of barium hydroxide was precipitated by carbon dioxide gas, the excess of carbon dioxide driven out by boiling, and the solution filtered. The filtrate was neutralised with a few drops of "apatite hydrochloric acid," evaporated to saturation and precipitated with alcohol. The ignited powder was reprecipitated with alcohol and then crystallised several times. The "ordinary sodium chloride" was evaporated to dryness, heated to redness, dissolved, filtered, and recrystallised several times.

After 3 days' rotation another weighing was made, No. 2 in the table. The specific gravity of the "ordinary sodium chloride" being unchanged shows the preparation to be pure, but the "apatite sodium chloride" was again treated as above, giving value No. 3. This solution was then evaporated to dryness, ignited, and recrystallised thrice. Weighing gave value No. 4, 1.202791, which agrees with that found for "ordinary sodium chloride," 1.202791 and 1.202790.

TABLE I.

SPECIFIC GRAVITIES OF SATURATED SOLUTIONS.¶

Temp., 18°

Expt.	"Ordinary Sodium Chloride"		"Apatite Sodium Chloride"
1	1.202791	1,202791	1.203698
2	1.202790		1.204691
3	....		1.203557
4	....		1.202791
5	....		1.202857
6	1.202867		1.202852

¶ *Vacuum corrections were applied to all weighings, taking 8.4 as the specific gravity of the brass weights by the usual formulæ.*

After the work had been abandoned for a time the "apatite sodium chloride" solution was evaporated, ignited, recrystallised two or three times, and the specific gravity again determined (No. 5). Another evaporation, ignition and recrystallsation gave value No. 6, the specific gravity of "ordinary sodium chloride" being determined at the same time.

The slight difference between the first and the last determinations for "ordinary sodium chloride" may be accounted for by a new setting of the thermostat regulator. The measurements taken at the same time under identical conditions are in good agreement. Thus the average for "ordinary sodium chloride" under the earlier conditions agrees precisely with the value for the purest "apatite sodium chloridse" (No. 4), while the later value, 1.202867, for "ordinary sodium cbloride" agrees closely with the average, 1.202855, of the later values for the still further purified "apatite sodium chloride."

A sample was then taken from each of the two solutions by means of the pycnometer and ignited to constant weight in platinum, all precautions being observed. When corrected to vacuum the "ordiuary sodium chloride" weighed 3.31262, while the "apatite sodium chloride" weighed 3.31267, or 0.05 mg. more, a difference less than the errors of weighing (0.1 mg.). It follows that the atomic weight of the apatite chlorine does not differ from that of ordinary chlorine by an appreciable amount. Even if the solubilities found (26.357 per cent at 18° or 35.790 g. per 100 g. of water) were not absolutely correct, the atomic weight 35.46 calculated from the relative values would still hold good.

Incidentally, we have compared the solubilities we found with those calculated from the formula of Andreae[3] which are in good agreement with many recent determinations.[4] The calculated value is 26.363 per cent., while we found 26.357 per cent., which is in excellent agreement.

SUMMARY.

The chlorine isotopes in Bamle apatite occur in the same proportion as in ordinary sodium chloride.

Christiania, Norway.

(From the "Journal of the American Chemical Society," July, 1923, 1577-1579). *[Contribution from the Chemeal Laboratory of the University of Wisconsin.]*

[3] *Andreae, J. prakt. Chem.*, 1884, XXIX., 467.

[4] *Taylor, J. Phys. Chem.*, 1896-1897, I., 718. *Berkeley, Phil. Trans.*, 1904, CCIII., 189. *Fontein, Z. physik. Chem.*, 1910, LXXIII., 212. *Cohen, ibid.*, 1912, LXXV. *Schreinemakers, Arch. Neer. sci. nat.*, XV.

THE ACTION OF SELENIUM OXYCHLORIDE ON PURE RUBBER.[1]

By Carl E. Frick.

In the studies on the oxychloride of selenium which have been in progress in this Laboratory, Lenher[2] has shown that pure rubber, vulcanised rubber, and vulcanite, react chemically with selenium oxychloride. It seemed advisable to undertake a quantitative study of this reaction, if possible, as any information would be interesting in view of our incomplete knowledge of the nature of the rubber hydrocarbon. The products obtained by the action of selenium oxychloride on 2 wild, and 2 plantation rubbers, and a synthetic rubber prepared from isoprene, were investigated.

Preparation of Materials.

Selenium Oxychloride.—The method of Lenher[3] was used.

Pure Rubber Hydrocarbon.—Samples[4] of crude, unworked rubber were washed in frequent changes of water until dirt and soluble impurities were removed, dried, and freed from resins by extraction with boiling acetone for 24 hours. The residue was freed from acetone and the rubber hydrocarbon dissolved in pure carbon tetrachloride. The undissolved protein was filtered off and the rubber precipitated by absolute alcohol. The sample was freed from alcohol, redissolved in carbon tetrachloride, reprecipitated by alcohol 7 times, and finally redissolved and kept in pure carbon tetrachloride. The following natural rubbers were used in this study: Upriver, fine, hard Para; first latex Pale Crepe; Upper Caucho Ball; and ribbed Smoked Sheet.

Synthetic "Isoprene Rubber." — This was prepared from pure isoprene by the well-known method discovered practically simultaneously by Mathews[5] in England and Harries[6] in Germany, using metallic sodium to effect the polymerisation. The rubbery mass was washed with acetone, dissolved in carbon tetrachloride, reprecipitated by alcohol, redissolved and reprecipitated several itmes, and thus purified in exactly the same manner as the natural rubbers. The sample was finally redissolved and kept in pure carbon tetrachloride.

Isoprene.—The isoprene was prepared from *dl*-limonene (dipentene) by passing the vapours over an electrically-heated platinum wire, using the principle of Harries' isoprene lamp.[7] The limonene was obtained from washed orange oil, which was over 96 per cent. pure limonene. The crude isoprene was free dfrom any contained amylene by allowing it to stand for several days in contact with barium dioxide, dried with fused calcium chloride and distilled, then dried with metallic sodium and redistilled, using a Vigreaux fractionation column. Ostromuislinskii's[8] method of purification by forming the tetrabromide and then removing the bromine by treatment with zinc dust at 0° in absolute alcohol solution was found to be impractical when it was desirable to prepare a litre or more of pure isoprene. The material was colourless; b.p., 33.2-33.8° (742 mm.).

Solvents.—Acetone was freshly distilled over anhydrous potassium carbonate, and the fraction boiling at 56-57° used. Carbon tetrachloride was purified by treatment with saturated chlorine water for several days in diffused sunlight. It was then washed thoroughly with distilled water, dried over fused calcium chloride and distilled.

Experimental Part.

When crude rubber, vulcanised rubber, or even vulcanite is placed in selenium oxychloride, a vigorous reaction sets in, and the rubber is dissolved with evolution of heat. The solution becomes reddish brown in colour and contains selenium monochloride and selenium, in addition to the decomposition products of the rubber. In order to study this reaction, it became evident at once that the reaction would have to be more carefully controlled, and further that

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[1] *This paper is constructed from a part of a thesis submitted by the author to the Graduate School of the University of Wisconsin in partial fulfilment of the requirements for the degree of Doctor of Philosophy, January, 1923.*

[2] *Lenher, Jour. Amer. Chem. Soc.*, 1921, XLIII., 29.

[3] *Lenher, ibid.*, 1920, XLII., 2498.

[4] *These samples were kindly furnished by Dr. W. C. Geer, of the B.F. Goodrich Co., and Prof. H. E. Simmons, of the University of Akron.*

[5] *Mathews and Strange, Brit. pat.* 24,790, 1912.

[6] *Harries, Ann.*, 1911, CCCLXXXIII., 157.

[7] *Harries and Gottlob, Ann.*, CCCLXXXIII., 228.

[8] *Ostromuislinskii, J. Russ. Phys. Chem. Soc.*, 1916, XLVII., 1988.

the results would be the easier to interpret, the purer the samples of rubber used. The reactions of selenium oxychloride on the purified rubber hydrocarbon in solution in carbon tetrachloride, were carried out in all cases as follows.

To a known quantity of a 5 per cent. solution by weight of pure rubber in dry carbon tetrachloride, cooled to 0°, was added slowly, with vigorous stirring, an excess of a 5 per cent. solution of selenium oxychloride in dry carbon tetrachloride, also cooled to 0°. The selenium oxychloride was added in slight excess as otherwise the solution could not be filtered because the excess of rubber clogs the filter. A yellowish-white, amorphous substance immediately settled. The solution was filtered quickly through a Büchner funnel, the precipitated material transferred to a beaker containing cold carbon tetrachloride and agitated in order to free the material from the slight excess of selenium oxychloride. This operation was repeated several times, using fresh portions of cold, dry carbon tetrachloride. The precipitated materia lwas finally brought on to the filter paper and the carbon tetrachloride replaced by ethyl ether. The ether was quickly evaporated, the dry, amorphous powder transferred to a glass-stoppered weighing bottle and this container kept at 0°. Due to its instability at ordinary room temperatures and the consequent evolution of hydrogen chloride, the material had to be handled in this way. This instability also prevented further purification of the material by any of the usual methods.

Table I. shows the comparative results based on the averages of all of the complete analyses of the various reaction products of selenium oxychloride with the natural rubbers and the synthetic isoprene

TABLE I.

AVERAGE ANALYSES[9] OF THE PRODUCTS OF THE REACTION BETWEEN RUBBER AND SELENIUM OXYCHLORIDE

$SeOCl_2$ reaction products with	C %	H %	Se %	Cl %	(Diff.) %	Ratio C:H
"Isoprene Rubber"	23.72	4.67	22.57	23.79	25.25	10:23.3
Pale Crepe	23.75	4.37	22.81	24.23	24.84	10:22.3
Smoked Sheet	21.60	4.66	27.04	24.69	22.01	10:26.0
Para	23.85	4.42	26.74	26.03	18.96	10:22.1
Caucho Ball	24.49	4.37	26.09	25.35	19.70	10:21.1

DISCUSSION.

Attention is called to several points brought out in this table. (1) It will be noted that the average content of carbon in the various reaction products of either synthetic rubber from isoprene, or the natural rubbers, varies less than 1 per cent., except in the case of the product from Smoked Sheet, which is about 2 per cent. lower. (2) The average contents of hydrogen in the various reaction products vary less than 0.4 of 1 per cent. (3) The average content of selenium in the synthetic isoprene-rubber product is practically the same as in the plantation Pale Crepe prduct. The amount of selenium in reaction products of the other natural rubbers, varies only within 1 per cent., but all are 4 to 5 per cent. higher than in the case of the Pale Crepe or the synthetic isoprene rubber. It will be noted, however, that the products from all 3 of the natural rubbers in which the latex was coagulated by smoke have a selenium content of 26 to 27 per cent. The Smoked Sheet comes from exactly the same source as the Pale Crepe (cultivated *Hevea brasiliensis*), but the latex of Pale Crepe is coagulated by acetic acid, while the latex of Smoked Sheet is only partially coagulated by acetic acid and is then smoked to complete the process. Possibly this difference in the selenium content of the 2 reaction products can be attributed to the method of coagulation. (4) The average content of chlorine in the various reaction products from either the synthetic or the natural rubber varies about 2.2 per cent. (5) The ratio o carbon to hydrogen has changed from $C_{10}H_{16}$ in the pure rubber, up to $C_{10}H_{26}$ in the reaction products. (6) Parallel with the chemical changes in the various kinds of rubber upon treatment with seleniu moxychloride, there

[9] *The "average analyses" are the means of the results of 10 to 12 determinations on different samples of the same material handled under as nearly the same conditions as possible. The average analysis for each constituent is accurate to at least 1 per cent.*

is a great change in their physical properties. The products are all amorphous powders, having lost their elasticity and swelling power, and are insoluble in the ordinary rubber solvents, such as benzene, carbon tetrachloride, chloroform and ether. (7) The two most important conclusions that can be drawn fro mthe comparative data on these reaction products are: (a) the pure rubber hydrocarbon from natural *Hevea* rubbers, shows a slightly different behaviour in its reaction with selenium oxychloride, depending upon the source of the rubber and its method of coagulation; (b) judging by the behaviour towards selenium oxychloride, there is no difference in empirical composition between the pure rubber from a typical natural rubber, such as Pale Crepe, and a synthetic rubber, made by the polymerisation of isoprene by metallic sodium. This statement is in contradiction to the recent article of Kirchof.[10] Kirchof has compared the ultimate analyses that have been made on the rubber hydrocarbon from different sources and also the analyses of the various derivatives that have been reported. He concluded that synthetic rubber is a true polymer of the corresponding hydrocarbon, C_5H_8, but that the hydrocarbon of Para rubber has the empirical composition $C_{10}H_{17}$, and cannot be formed from the hydrocarbon C_5H_8 through polymerisation, as Harries supposed. According to Kirchof, neither the empirical composition nor the structure of synthetic rubber is identical with that of Para rubber.

The present work tends to support the conclusion that Harries reached after a study of the hydrolysis products of the ozonides of various kinds of natural and synthetic rubbers, namely, that there is no essential difference in constitution between natural rubber and the polymerised isoprene.

The author wishes to express his appreciation to Professor Victor Lenher, at whose suggestion and under whose direction this work was carried out; also to Professor Homer Adkins for helpful suggestions.

SUMMARY.

1. *The reactions* between selenium oxychloride and the natural, *Hevea* rubbers, Smoked Sheet, Para and Caucho studied.

2. The reaction between selenium oxychloride and a synthetic rubber made by polymerising isoprene has been studied.

3. It has been found that when the various rubbers are treated with selenium oxychloride their physical properties are changed. The products are all amorphous powders, having lost their elasticity and swelling power, and are insoluble in the ordinary solvents for rubber.

4. It has been shown that the pure rubber hydrocarbon from natural, *Hevea* rubbers, shows a slightly different behaviour in its reaction with selenium oxychloride, depending upon the source of the rubber and its method of coagulation.

5. It has been shown definitely that, judging by their respective behaviours towards selenium oxychloride, there is no difference in empirical composition between the pure rubber hydrocarbon from the *Hevea* tree and the synthetic rubber made by polymerising isoprene with metallic sodium.

[4] *These* ... *Dr. W. C. Geer, and Prof. H. E. Sm... of Akron.*

[5] *Mathews and Strange, Beihefte,* 1922,

Madison, Wisconsin.

(From the "Journal of the American Chemical Society," July, 1923, 1800-1804).

SOCIETY OF GLASS TECHNOLOGY.

In connection with the visit of members of the Society of Glass Technology to France, during the first week of July, two meetings with French glass manufacturers were held on Monday July 2. In the morning, the visiting party was received by the Chambre Syndicale des Maîtres Verreries, and was welcomed by its President, Mons. L. Houdaille, who described to the visitors how the French glass manufacturers were all united in one body—the Chambre Syndicale—which was divided into six sections representing various branches of the industry. The work of these sections was organised in such a way as to prevent ruinous competition between members, and at the same time encouraged individual research and development. Mons. L. Delloye spoke of the need for co-operation among manufacturers of different countries. Prof. W. E. S. Turner, Col. S. C. Halse and Mr. E. A. Hailwood replied for the Society of Glass Technology.

In the afternoon (after a lunch at which visiting members were the guests of the

Chambre Syndicale des Maîtres Verreries), a joint meeting of the Société des Ingénieurs Civils and the Society of Glass Technology was held. In the absence of Mons. Guillet, President of the Société des Ingénieurs Civils, Mons. L. Delloye welcomed the visitors. The following papers were communicated:—

PROF. H. LE CHATELIER, *La Méthode Scientifique dans l'Industrie.*

DR. A. GRANGER. *Les Verres Opaques et Colorés, et les Glacures Céramiques de Même Espèce.*

MONS. LAFON, *La Dilatation des Verres et Cristaux.*

PROF. W. E. S. TURNER, *Specifications for Glass Products.*

MR. T. TEISEN, *Improvements in the Design of Recuperative Glass Pot Furnaces.*

MR. S. ENGLISH and PROF. W. E. S. TURNER, *The Physical Properties of Boric Oxide Glasses.*

During the week-end visits were paid to the following glass works: (a) Etablissements Legras at St. Denis, (b) Verreries de Reims (Messrs. Charbonneaux & Cie), (c) New plate glass works at Chantereine, (d) Glaceries de St. Gobain, Chauny and Cirey. Members took the opportunity when at Reims of visiting the battlefields in that district. A visit was also paid to the sand quarries at Nemours, and to the Forest and Castle of Fontainebleau.

The social side of the excursion was not neglected. In addition to the reception and lunch already mentioned, a complimentary dinner was given by members of the visiting party to Mons. L. Delloye, who had been responsible for making all the arrangements on the French side. At Noyon the party was kindly invited to lunch by the directors of Les Glaceries de St. Gobain, Chauny and Cirey. A reception was also given to visitors by Mons. G. Despret (Administrateur des Verreries de Boussois), Paris, when an interesting exhibition of artistic glass was on view.

Altogether, some thirty British members of the Society and their friends took part in the visit. It will be recalled that a party of members of the Society visited America in 1920. Encouraged by the success of both these visits it is proposed to arrange other tours as opportunity arises.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

JULY EXAMINATIONS: 1923.—PASS LIST.

The following candidates have passed the examination for the Associateship:—

In General Chemistry: Anderson, Alex Carr, B.Sc. (Lond.), University College, Nottingham; Barnett, John, East London College; Beard, Herbert Greensmith, Huddersfield Technical College; Bennett, William Frederick, Central Technical School, Liverpool; Booth, Walter, Central Technical School, Leeds; Bott, Thomas Harold, B.Sc. (Lond.), College of Technology, Manchester; Bubb, Frederick James, B.Sc. (Lond.), East London College; Child, Reginald, King's College, London; Crombie, William, Imperial College of Science and Technology; Crutchlow, Bernard William Alfred, King's College, London; Curtis, Ronald Hamilton, University College, London; Faichney, Peter, Heriot-Watt College, Edinburgh; Fairgrieve, Adam Wilson, Heriot-Watt College, Edinburgh; Groves, Adam Traill, Heriot-Watt College, Edinburgh; Harrow, Andrew Nicoll, Heriot-Watt College, Edinburgh; Hibbert, Sydney, A.M.C.T., College of Technology, Manchester; Hill, Herbert Eric, University of Western Australia; Jones, Norman Ellathorne, King's College, London; Kimmins, Lionel George, B.Sc. (Lond.), University College, London; Kirby, Christopher Stanhope, University College, London; Laing, William Mossman, Heriot-Watt College, Edinburgh; Leaper, Percy Joshua, University College, Southampton; Lindsay, Robert, University College, London; McGrath, James, Royal Technical College, Glasgow; Mieras, Adrian Pieter, Heriot-Watt College, Edinburgh; Mosley, Martin Aaron, University College, Nottingham; Moyes, Robert Baird, Heriot-Watt College, Edinburgh; Oliver, James Herbert, B.Sc. (Lond.); Paul, David, Heriot-Watt College, Edinburgh; Pound, Albert, B.Sc. (Lond.), University College, Exeter; Rosewarne, Joel Alfred Henry Tetterdell, King's College, London; Russell, William Lyle, Heriot-Watt College, Edinburgh; Saunders, Harold Nicholas, B.Sc. (Lond.), University College, Exeter; Scott, Robert, Heriot-Watt College, Edinburgh; Smith, Charles George, King's College, London; Snelus, Miss Suzanne Mabel Lavinia, College of Technology, Manchester, and Sir John Cass Technical Institute; Thacker, Gilbert Doe Dwyer

Way, East London College; Thomas, Brynmor, M.Sc. (Dun.), Central Technical School, Liverpool; Threadgold, Herbert, B.Sc. (Lond.), University College, London; Tully, James Duncan, B.Sc. (Lond.), University College, Southampton; Walker, John, Technical College, Huddersfield; Wells, William Herbert, University College, London; Wilkie, Alexander Stewart, Heriot-Watt College, Edinburgh; Wilson, George Edward, Heriot-Watt College, Edinburgh; Wood, Thomas, Central Technical School, Liverpool; Wylie, Andrew Robertson, Heriot-Watt College, Edinburgh. (28 candidates failed to satisfy the examiners.)

In Branch (b): Metallurgical Chemistry: Howard, Thomas George, Sir John Cass Technical Institute.

In Branch (e): Chemistry, including Microscopy, of Food and Drugs, and Water: Woodhead, John Ezra, B.Sc. (Lond.), Birkbeck College, and Northern Polytechnic Institute, London.

In Branch (g): Chemical Technology: Martin, George Frank, Royal College of Science, London.

The following Associates have passed the examination for the Fellowship:—

In Branch A: Inorganic Chemistry:

Hackney, Norman, B.Sc. (Lond.); Wynn, William Owen Roderick.

In Branch C: Organic Chemistry: Cohen, Abraham, B.Sc. (Lond.).

In Branch D: Agricultural Chemistry: Ritchie, John Edwin, M.A., B.Sc. (Aberd.).

By *Order of the Council,*

RICHARD B. PILCHER,
Registrar and Secretary.

30, Russell Square, London, W.C.1.
June 27, 1923.

PRESENTATION OF THE SOCIETY'S ALBERT MEDAL TO SIR DAVID BRUCE AND SIR RONALD ROSS.

he Council of the Royal Society of Arts attended at Clarence House, St. James's, on July 13, when His Royal Highness, the Duke of Connaught and Strathearn, K.G., President of the Society, presented the Society's Albert Medal for the present year in duplicate to Major-General Sir David [illegible] F.R.S., and Colonel Sir Ronald Ross, K.C.B., K.C.M.G., D.Sc., LL.D., M.D., F.R.C.S., F.R.S., "in recognition of the eminent services they have rendered to the Economic Development of the World by their achievements in Biological Research and the Study of Tropical Diseases."

The Duke of Connaught was attended by Lieut.-Colonel Sir Malcolm Murray, K.C.V.O., C.B., C.I.E.

A PEROXIDE ELECTRIC CELL.

By A. E. J. PETTET & A. W. WARRINGTON.

The writers apologise if the cell they are about to describe is not new.

The elements and pots of an ordinary Bunsen cell are used. The zinc is amalgamated and placed in the outer cell, containing a solution of zinc sulphate (144 gm. of the crystallised salt per litre). The carbon is placed in the porous jar and is in contact with a "20" volume solution of hydrogen peroxide, acidified with sulphuric acid (one volume of acid to every ten volumes of the peroxide.).

The cell very rapidly reaches its full strength. Its E.M.F. is about 1.6 volts. The internal resistance of the cell used by the writers was about 1 ohm. (The outer cell had a liquid capacity of about 480 c.c., and the inner cell of about 210 c.c.) The cell is very clean to work with, and for renewal only the contents of the inner compartment need be replenished. It may be left for about a week on open circuit without appreciable deterioration.

The cell is very constant. With a current of 0.06 ampere it will run for 48 hours unchanged, and for another 24 hours with only a slight fall in current. If used continuously it has a total output of about 26,500 (25,000) coulombs. It runs down quite rapidly at the end of about three days, owing to decomposition of the peroxide. It worked well, however, until only about one-twentieth of the original amount of available oxygen was present.

It is admirably adapted for use with a copper voltameter. Running for one hou[r] through a copper voltameter, and carryin[g] a mean current of 0.2082 ampere, th[e] highest reading of the galvanometer, th[e] needle of which was suspended by a sil[k] fibre, indicated a current of 0.2185, and th[e] lowest of 0.2019 ampere. Running for tw[o] hours through a copper voltameter, an[d] carrying a mean current of 0.0990 amper[e]

the current varied between 0.0998 and 0.986. With a current of 0.06 ampere it will run continuously for two or three days, as already stated, with almost inappreciable change in current strength.

The writers have no hesitation in recommending its use in schools in place of the Daniell cell.

ARTIFICIAL SILK.

Canadian Chemistry and Metallurgy, July, 1923.

Artificial silk is the rather inappropriate name given to a product of cotton or wood fibre which differs both physically and chemically from the gum of the silk worm. So long as it is called "artificial" a certain prejudice against its use is bound to exist, as was the case with cotton in its early days when it was looked upon as a substitute for linen. Cellulose silk—a more fitting term—is a commodity in a class of its own, and of indisputable value. The world's present output, though nearly twice that of pre-war days, is far from sufficient to meet the demand, and the industry, wherever carried on, is enjoying a prosperity that suffered no interruption even in the 1921 period of general business depression. The great artificial silk firm of England, Courtaulds, Limited, reported a net profit for 1922 of £3,018,431, which compares with £1,684,593 in 1921 and £1,804,796 in 1920.

Of the four processes in common use for the making of cellulose silk, the most popular is the viscose, which is an entirely British discovery, depending upon the formation of a soluble xanthate compound. The raw material for this process is wood pulp, and the principal chemical reagents caustic soda and carbon bisulphide. The viscose factories in Europe draw their supplies of sulphite pulp from Scandinavia and Canada. It is the labour, however, not the raw material, that constitutes the heaviest item of cost; but this will not be so much in evidence when the present machinery is improved and additional mechanism applied.

The possibilities of cellulose silk appear to be almost limitless. It is extensively used in the braiding and millinery industries; and, woven with real silk, wool, cotton or other fibres, it is gaining in importance every day in the manufacture of wearing apparel and of beautiful textures of all kinds. Ribbon straw, artificial horsehair, cloth, and even imitation Smyrna rugs and Gobelin tapestries are now made in artificial silk plants. Though not a substitute for natural silk, cellulose silk has a broad market on account of its comparative cheapness, and the world's output will soon exceed that of cocoon silk. The chemistry of cellulose offers unlimited scope for research, so new developments can be looked forward to that will still further extend the use of cellulose silk.

In view of the Finance Minister's tariff recommendations and the trading advantages Canada has with some countries through her preferential tariffs, the time would appear to be opportune for examining fully into the feasibility of establishing the cellulose silk chemical industry in Canada. Sulphite pulp and the necessary chemicals can be manufactured cheaply, and our domestic market is not insignificant, as statistics for 1922 reveal that over $2,000,000 was expended on imports of cellulose-silk yarn and filaments, about $1,000,000 on manufactures from the United States and the United Kingdom alone, and large quantities—not to be identified in trade figures—of fabrics from these and other countries.

Just as we go to press we learn that the large British firm of Courtaulds has decided to establish a plant near Quebec City for the manufacture of artificial silk yarn. Truly we are getting on.

NOTICES OF BOOKS.

Organic Chemistry, by Ira Remsen, Revised and Enlarged by W. R. Orndorff. Pp. XI. + 567. London: Macmillan & Co., Ltd., St. Martin Street, W.C.2. 1923. 10s. net.

Prof. Remsen's textbooks possess the admirable quality from the teaching standpoint, of being simple and containing a minimum of descriptive matter.

This volume on Organic Chemistry is not over-burdened with the modes of preparation and the properties of countless compounds. Indeed, in this edition, revised with the help of Prof. Orndorff, the practical directions for preparing even important substances has been omitted. This is not, however, a serious drawback, since it allows more attention to be devoted to principles and generalisations. Further, it is now customary to use laboratory manuals in connection with practical organic chemistry.

The judicious introduction of new discoveries and developments has been ably

done, and very few errors — and these are trivial—have been noticed.

This new and enlarged edition is well adapted fo rthe use of students attending an introductory course of Organic Chemistry, and should commend itself to lecturers in the subject.

CHEMICAL SOCIETY'S LIBRARY.

Owing to the work of redecorating the rooms of the Society, the Library will be closed during the entire month of August, and in accordance with the usual practice will close at 5 p.m. daily from September 1 to 17

NOTES.

Messrs. Longmans, Green & Co. announce that the new edition of Sir Edward Thorpe's *Dictionary of Applied Chemistry* will extend to seven volumes, a great part of the last volume being devoted to a complete index to the work.

BOOKS RECEIVED.

Etude sur la Tannerie et les Industries connexes au Maroc, Ch. ZIEGLER INGENIEUR CHIMISTE. Pp. 122. 1923. La Chaussiere Francaise. 141, Boulevard Sebastopol, Paris. 7fr. 50c.

The Ventilation of Public Buildings, by ROBERT BOYLE. Pp. LI. + V. 1923. Messrs. Robert Boyle & Son, 64, Holborn Viaduct, E.C.1. 6s. net.

The Publications Department, Bournville, has issued two pamphlets by A. W. KNAPP, B.Sc., F.I.C., entitled *The Application of Science to Cacao Production*, and *The Separation and Uses of Cacao Shell*, price 6d. each.

The articles were originally prepared for the International Congress of Tropical Agriculture, and appeared originally in the *Journal of the Society of Chemical Industry*, but have been revised and brought up-to-date.

Both are interesting and informative, and are written in a way suitable for those who are not specialists in this particular subject.

The U.S. Department of the Interior, Bureau of Mines, has issued the following bulletins:—

No. 204. *Underground Ventilation at Butte*, by DANIEL HARRINGTON. Pp. 31.

No. 339. *Coal-Mine Fatalities in the United States*, 1922, by WM. W. ADAMS. Pp. VI. 97

No. 340. *Production of Explosives in the United States during the Calendar Year* 1922, by WILLIAM W. ADAMS. Pp. 25.

New Patents.

THIS list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

18008—Bloxam, A. G.—Manufacture of azo dyestuffs. July 11.

18087—Bodrero, B.—Production and use of sulphuro-phosphate. July 12.

18061—Dreyfus, H.—Treatment of cellulose derivatibes. July 12.

18092—Farbwerke vorm. Meister, Lucius, and Bruning.—Manufacture of highly-active charcoal. July 12.

17764—Lilienfield, L.—Manufacture of cellulose ethers. July 9.

17806—Moeller, J. F. L.—Method of treating carbonaceous materials. July 10.

17837—Moeller, J. F. L.—Fractional distillation of hydrocarbons. July 10.

18107—Trumble, M. J.—Treating hydrocarbons. July 12.

18250—Vogel, H.—Manufacture of colloidal sulphur. July 14.

Specifications Published this Week.

199750—Joyner, R. A., and Nobel's Explosive Co., Ltd.—Manufacture of hydrazine.

166759—Hirchberg, L. M. Manufacture of aqueous solutions of formaldehyde.

199760—Hirchber, L. M.—Production of formaldehyde by catalysis.

199766—Hanna, R. W.—Process for the continuous production of low boiling-point hydrocarbons from petroleum oils.

199870—Farbwerke vorm. Meister, Lucius, and Bruning.—Manufacture of therapeutically active acridine derivatives.

188335—Appareils et Evaporateurs Kestner.—Process of extracting sodium bicarbonate and other salts contained in natural soda bicarbonated mineral waters.

Abstract Published this Week.

197848—Thymol.—Howard & Sons, Ltd., Uphall Works, Ilford, and J. Blagden, Apple Tree House, Grove Road, South Woodford, both in Essex.

Thymol, thymol sulphonic acids, m-cresol sulphonic acids.—Thymol is prepared by sulphonating *m*-cresol under conditions suitable for producing a polysulphonic acid, such as the di- or even tri-sulphonic acid, which is then condensed with isopropyl alcohol, the sulphonic groups split off and the thymol steam-distilled. According to an example *m*-cresol is treated with oleum, containing 88 per cent. total sulphur trioxide, first at 100° and then at 150° C. A solution of isopropyl alcohol in sulphuric acid is run in and the mixture maintained at 80-90° C. for several hours. It is then heated to 130° C. and a current of steam passed in, the thymol distilling off. A small quantity of by-product may be removed by solution of the thymol in alkali. A little isomeric thymol, melting at 114° C., is also formed.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,

VOL. CXXVII. No. 3304.

PERCHROMIC ACID.

By Geoffrey N. Ridley.

I.—Formulæ.

Perchromic acid has been given two formulæ—$HCrO_5$ and H_3CrO_8. It therefore deviates from the path followed by its "relative," permanganic acid, whose formula is given as $HMnO_4$ or $H_2Mn_2O_8$. The equation representing the formation of the acid by the interaction of chromic acid and hydrogen peroxide may be written thus:

$2H_2CrO_4 + 7H_2O_2 = 2H_3CrO_8 + 6H_2O$.

This reaction occurs when the hydrogen peroxide is in excess. Otherwise, acid corresponding to the probable formula $HCrO_5$ is produced. In the hypothetical case of the formula for perchromic acid being $H_2Cr_2O_8$, the formation of the compound may be expressed thus:

$2H_2CrO_4 + H_2O_2 = H_2Cr_2O_8 + 2H_2O$.

It has been suggested that chromium may form an octovalent compound, perchromic acid consisting of a combination of Cr_2O_7 with H_2O_2, or CrO_4 with H_2O.

II.—Chemical Behaviour.

The etherial solution of perchromic acid reacts with an alkaline carbonate, such as sodium carbonate, resulting in the production of a normal chromate.

(α) $4HCrO_5 + 4Na_2CO_3 = 4Na_2CrO_4 + 4CO_2 + 2H_2O + 3O_2$.

(β) $4H_3CrO_8 + 4Na_2CO_3 = 4Na_2CrO_4 + 6H_2O + 4CO_2 + 7O_2$.

A *perchromate of sodium does not appear* to be formed by the direct reaction between carbonate and acid, but a sodium perchromate, $Na_6Cr_2O_{16},28H_2O$, may be prepared by adding Na_2O_2 to an aqueous paste of $Cr(OH)_3$.

The solution of perchromic acid has an acid reaction towards litmus, and acts upon magnesium with appreciable vigour. The metal becomes coated with a deposit of magnesium chromate, portions of which are converted into the dichromate:

(α) $4HCrO_5 + 4Mg = 4MgCrO_4 + 2H_2O + O_2$.

(β) $4H_3CrO_8 + 4Mg = 4MgCrO_4 + 6H_2O + 5O_2$.

Perchromic acid is without action upon copper. Chemical activity between the acid and phosphorus is not visible, but on warming and allowing the ether to slowly evaporate, a greenish substance is left, which, in view of its chemical behaviour, is thought to be a phosphide of chromium.

III.—Decomposition.

Perchromic acid undergoes decomposition by:

(a) Nascent hydrogen.
(b) Acids.
(c) Compounds, viz., carbonates.
(d) Metals, viz., magnesium.
(e) Water.
(f) Rise in temperature.

The reduction by hydrogen is expressed thus:

(α) $2HCrO_5 + 3H_2 = 2H_2CrO_4 + 2H_2O$

(β) $2H_3CrO_8 + 7H_2 = 2H_2CrO_4 + 8H_2O$.

The addition of strong sulphuric acid to perchromic acid brings about the rapid dissolution of the blue compound, accompanied by the evolution of a considerable quantity of oxygen:

(α) $2HCrO_5 + 3H_2SO_4 = Cr_2(SO_4)_3 + 4H_2O + 3O_2$.

(β) $2H_3CrO_8 + 3H_2SO_4 = Cr_2(SO_4)_3 + 6H_2O + 5O_2$.

As regards the decomposition of perchromic acid by water, the action is slow and only brought about in a short space of time by much shaking. The acid is gradually removed from the ether colouring the water a pale purple, which readily changes to a brownish-red, whence it is concluded that either dichromic or chromic acid is in solution.

If a small quantity of acetone is added to the etherial solution of perchromic acid, the fluid may be heated gently to a temperature neighbouring on 50° C. The blue colour of the liquid gradually changes through grey to purple and to dark reddish-brown. This is, in all probability, dichromic acid, and its formation may be expressed thus:

(α) $4HCrO_5 \rightarrow 2H_2CrO_4, CrO_3 + 3O_2$.

(β) $4H_3CrO_8 \rightarrow 2H_2CrO_4,CrO_3 + 4H_2O + 7O_2$.

What may be called the "conditions of preservation" of perchromic acid constitute important determining factors in connection with the decomposition of the compound. The conditions of preservation are:—Low temperature and in a free state; ordi-

nary temperature and in solution; ordinary temperature and free; elevated temperature *and in solution, the solvent being* ether.

The relation between these conditions the dissolution of perchromic acid is shc in the table.

	Remarks on Decomposition.	
Condition of Preservation.	Temperature.	Speed.
Low temperature. Free state. Solid.	-20° C. to -25° C.	Rapid.
Ordinary temperature. In solution.	Ordinary temp.	Very slow. (Several hours.)
Ordinary temperature. Free state.	Ordinary temp.	Immediate.
High temperature. In solution.	35° C. to 50° C.	Gradual.

The general remark is: that perchromic acid, when in solution, owes its stability to the solvent; when free, to the temperature.

IV.—Isolation.

The following remarks with regard to the crystallising of perchromic acid may be of interest.

Perchromic acid has been isolated; briefly the process is this:

A *solution of chromium trioxide in* methyl ether at -30° C. is treated with 97 per cent. *hydrogen peroxide* solution. The blue crystals formed are said to be those of perchromic acid.

If, on the other hand, a frozen soluti of potassium dichromate at -12° C. treated with conveniently cooled and acid lated hydrogen peroxide, the superincu bent ether assumes a deep blue colour. T temperature being low, all remains soli allowing the blue etherial solution to poured off. At a temperature between -2 and -25° C. this liquid deposits blue cry tals, which melt very rapidly when remov from the freezing bath.

This experiment was carried out by th writer previous to receiving informati concerning the method by which pe chromic acid was isolated in 1914.

ORGANIC COMPOUNDS OF ARSENIC.

PART II.

By R. F. Hunter, F.C.S.

In Part I. some account was given of atoxyl in general terms; and it is now proposed to treat the matter more thoroughly.

Atoxyl.

Owing to theoretical considerations current *among* the French school of chemists of Béchamp's time, Béchamp was prevented *from arriving at the correct conclusion* for his reaction, and further, the chemists *of his day refused to regard* his compound obtained from arsenic acid and aniline as a true organic arsenic compound, and, as stated in Part I., not until the work of Ehrlich, to whom we owe the discovery of our present most efficient cure for syphillus, appeared in the year 1907, was the true nature of Béchamp's compound demonand further, the commercial sodium cor pound to be

$NH_2C_6H_4AsO\ (OH)\ O\ Na\ n\ H_2O$,

where n varies between 2 and 6.

Researchers in this field following Eh lich, applied the Béchamp reaction to oth aromatic amines with a free para. positio this led to the discovery of 2-aminotolyl-arsenic acid from o-toluidine.

As stated before, the main trouble i volved in the use of atoxyl for injections *its toxic nature; acetylation in the case* such compounds as aniline had yielded t *less toxic acetanilide. Consequently* atox was acetylated, and a drug of constitution $CH_3C\ O\ N\ H\ C_6H_4\ As\ O\ (OH)\ O\ Na\ n\ H_2O$ was introduced.

It is necessary to examine systematical the derivatives of atoxyl, and I propose t again use Gibson's method of classificatio

Gibson, in his recent work: *Organic con pounds of arsenic and antimony,* h divided the atoxyl derivative as follows:—

heating corresponding quantities of aniline and arsenic-acid at 180° for some two hours.

$C_6H_5NH_2+H_3As\ O_4 =$
$NH_2C_6H_4\ As\ O\ (OH)_2 + H_2O$,

the *sodium salt is, of course*, atoxyl.

Mercuric derivative of p Arsanilic acid.

Sometimes known as "Asyphil," has sometimes been used for injection in the case of syphillis, it has a structure

$[NH_2\ C_6H_4AsO\ (CH)\ O]_2\ Hg$.

The important acyl derivatice of atoxyl is the acetylone "Arsacelin" which is sodium Acelyl p-arsenilate and has received considerable application.

Some other acyl derivatives are:

Formyl, chloracetyl, butyryl, malonyl, benzoyl, allylthio carbamino, theo carbamino, methyl carbamino, phenyl carbamino, *p-arsanilic* acids.

p-Sulphomethyl aminophenylarsinic acid.

$SO_3\ H\ CH_3NH_2C_6H_4\ AsO\ (OH)_2$ is worthy of note, and is prepared by treating atoxyl with formaldehyde and sodium bisulphite in aqueous solution.

Three other series of compounds belonging to the group are:—

Aldehyde condensation products of atoxyl phenylylycine arsenic acid and homologues and phenylmethyl glycine parsene acid and its c. esters.

(2) Isomerides of p-Arsanilic acid, viz., m-Aminophenylarsenic acid and its derivatives.

(3) *Homologues* and *substitution* products of p-Arsenilic acid homologues, such as Aminotolyarsenic acids, the 2-aminotolyl-5-arsenic acid is important, and the sodium derivative $NH_2\ C_6H_3(CH_3)\ AsO\ (OH)\ O\ Na$ has found application under the title of "Kharsin."

o-Anisidine-4-arsenic acid is the most common derivative. 2:Acetyl 1:5 benzarsenic acid is an interesting example of an aminobenzarsenic acid.

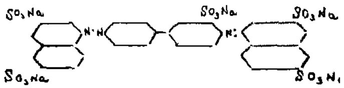
The halogen derivatives are not important, the thio derivatives are classified under

(*a*) Disulphides,
(*b*) Sesquisulphides,
(*c*) Monosulphides.

(4) Homologues and derivatives of o-Arsanilic acid 4-aminotolyl-3-arsenic acid is worthy of mention prepared from p-toluidine and H_3AsO_4.

(5) Nitroso, azo, diazo and triazo phenyl arsenic acids and derivatives.

The azo compounds are of use in medicine since they have a fatal effect on the protozoa of certain diseases, for instance, trypan red had been used in sleeping sickness, and has a structure,

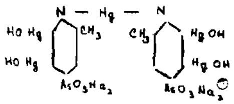


aud is prepared by diazotisation of both amino groups in *benzidine* or the sulphonic acid and coupling with 2-naphthylamine-3:6-disulphonic acid.

(6) *Organo mercurial compounds of* p-Arsenilic acid and derivatives.

From the beneficial results of the use of mercury compounds in the treatment of venereal disease, we should expect a compound of the nature of p-arsenilic acid and mercury to be quite a good cure. Consequently it was attempted to combine the therapeutic properties of mercury with those of atoxyl, and the results were beneficial. Condensation of mercury acetate with atoxyl being *main reaction*, *from* which were obtained on successive concentration sodium 3:5-dehydroxymercuri-4-aminophenylarsinate.

A new compound tested clinically with poor results is "Hydryl," which has the composition,



(7) 4:4′ Diaminodiaryl arsenic acids. These were discovered as a result of applying the Béchamp condensation to aniline and o-toluidine.

4:4′ Diaminodiphenylarsenic acid.

$(NH_2\ C_6H_4)_2$ As O OH is the best example.

(8) Mixed aromatic aliphatic p-amino arsenic acids.

(9) Nitro derivatives of arsenilic acids.

Some of these are important:

5-nitro-2-aminophenylarsenic acid.
6-Nitro-m-arsenilic acid.
2-nitro-4-aminophenylarsenic acid.
2-nitro-3-aminophenylarsenic acid.
3-nitro-4aminophenylarsenic acid are worthy of note.

(10)Diaminophenylarsenic acids:

Examples of these are:

2:3 diaminophenylarsenic acid,
$(NH_2)_2\ C_6H_3\ As\ O_3H_2$.

3:4 *Diaminophenylarsenic* acid are examples.

(11) The Hydronyphenylarsenic acids. *Phenol-p-arsenic* and homologues.

These are of interest and represent the extension of the Béchamp condensation of phenols.

Phenol-p-arsenic acid,

P HO C_6H_4 AsO $(OH)_2$,

is prepared by heating phenol and arsenic *acid in proportions* required by theory.

o-Cresol-4-arsenic acid,

$HOCH_3$ C_6H_3 As O $(OH)_2$,

in same manner from o-Cresol and corresponding m-compound.

Naphthol-4-arsenic acid, HO $C_{10}H_6AsO(OH)_2$, *is obtained by adding iced* $NaNO_2$ solution to 1-aminonathphyl-4-arsenic acid in 15 per cent. H_2SO_4.

2-*Hydroxy-1:5-Benzarsenic acid,*

HO (CO_2H) C_6H_3 As O $(OH)_2$,

prepared from 2-acetylaminotolyl-5-arsenic acid by oxidation with $KMnO_4$ followed by NaOH hydrolysis. Its sodium salt is less toxic and is used sometimes in cases of syphilis.

2:4 Dehydroxyphenylarsenic acid.

2-Methoxy-4-*hydroxyphenylarsenic acid.*

2:4-dimethoxyphenylarsenic acid.

3:4-dehydroxyphenylarsenic acid and 4:-4-*dehydroxydiphenylarsenic acid have* also been prepared.

(12) Nitro derivatives of hydroxyphenylarsenic acids.

3-nitro-4-hydroxyphenylarsenic acid is produced by nitration of sodium. p-Phenol arsenate with a mixture of HNO_3 and H_2SO_4 at 0° C., and has a structure,

HO (NO_2) C_6H_3 As O $(OH)_2$.

4-nitro-2-hydroxyphenylarsenic acid is *prepared from diazotisation of* 4-*nitro*-2-aminophenol, followed by warming to decompose diazo salt.

5-*nitro-2-hydroxyphenylarsenic acid,* 3:5-dinitro-2-hydroxyphenylarsenic acid, and 5-nitro-2:4-dehydroxyphenylarsenic acid have been prepared, and are worthy of mention.

(13) Arsenic acids of amino phenols. 3-amino-4-hydroxyphenylarsenic acid,

HO (NH_2) C_6H_3 As O $(OH)_2$,

s typical and is prepared by reduction of corresponding nitro compound.

3-amino-2-hydroxytolyl-5-arsenic acid, 4-amino-3-hydroxyphenylarsenic acid, carbethoxy, 3-aminophenol-6-arsenic acid. 4-dimethyl amino-2-hydroxyphenylarsenic acid, and 3:5-diamino-4-hydroxyphenylarsenic acid have been described and deserve mention.

PAN FORMATION IN SOILS IN THE LIGHT OF THE LIESEGANG PHENOMENON.

By N. G. Chatterji, D.Sc., A.I.C.

The formation of pans in soils has been the subject of much investigation, and it *may now be taken for granted that the* whole process is intimately connected with the colloidal properties of soils. The latest work on the subject has been ably summarised by Morison (*Trans. Farad. Soc.*, 1922, XVII., 2, 321-323), in which the author comes to the conclusion that the whole process is a transformation of soil colloids *from the "sol" to the "gel" form with sub*sequent dehydration and deposition.

Whilst substantially agreeing with the above conclusion, an attempt has been made in the present paper to bring forward *evidence showing the similarity between* pan formation and that general type of periodic precipitation known as Liesegang phenomenon, after the name of the discoverer. This phenomenon was first observed by the discoverer when doing the following experiment:—

A glass plate was coated with 5 per cent. gelatin solution containing a small amount of potassium chromate. A drop of strong silver nitrate solution was then placed on the gel, and it immediately began to diffuse into the latter. The silver nitrate, of course, reacted with the chromate in the gel, forming *the insoluble red silver chromate.* But although there was a continuous supply of both the components, the insoluble silver salt was, however, not deposited in a continuous zone round the periphery of the original drop, but in a series of concentric rings, separated by apparently clear zones.

The general conditions observed with the soils in which pans are formed are here given briefly, taken mainly from a paper on the subject by Morison and Sothers (*Journ. Agri. Scien.*, 1914, VI., 84). The pan layer *in a soil consists more or less of a* well-defined band of material where the gradual transition from the surface to the underground soil is broken. The characteristics of this layer are a large diminution of pore space of the soil cutting off the air and water movement and preventing the penetration *of plant roots. The concentration of the* soil into such a layer may be of two kinds: it may be caused by the continued passage of heavy instruments of tillage to a given depth, or by the removal of material either

in the form of colloid sols or in the state of solution and its deposition at lower depths in the soil where it acts as the cementing material to the normal soil particles.

The present paper is concerned with the latter kind of pan.

Pan formation of this nature is almost always confined to soils composed for the most part of quartz sand, and as the normal drainage in such soils is rapid, the existence of the impervious layer is very marked. The pan layer, which occurs at a depth of 5-60 cms., varies in colour from a dark brown to a reddish yellow. The subsoil appears to be the ordinary and typical sand of the locality, unaltered in any way. The zone immediately above the pan is remarkable in the fact that it is almost free of iron and aluminium, and hence has a bleached appearance. The surface soil is usually rich in acid humus, and is almost completely free from calcium carbonate. The analytical figures for two typical samples of pan-bearing soils are given below:

	Frendenstadt, Swarzwald.			Swarzwald.		
	Bleached sand.	Pan layer.	Subsoil.	Bleached sand.	Pan layer.	Subsoil.
Fe_2O_3	0.253	1.857	0.906	0.193	0.767	0.552
Al_2O_3	0.180	4.946	1.268	0.455	2.133	0.975
CaO	trace	0.019	0.210	0.031	0.036	0.029
MgO	0.015	0.118	0.088	0.011	0.025	0.031

The main facts, therefore, in connection with the presence of pans in soils are the following:

(1) The formation of pans generally in sandy soils of open texture.

(2) A considerable accumulation of organic matter in the surface soil.

(3) Concentration of iron and aluminium hydroxides in the pan layer and other lower layers.

(4) The almost complete absence of calcium carbonate in the surface soil.

Various theories have from time to time been advanced to explain this phenomenon from the chemical point of view, such as the alternate reduction and oxidation of iron humates, but an exhaustive examination of these (Morison and Sothers, *loc. cit.*, Stremme, *Kolloid Zeitsch.*, 1917, XX., 161) shows that the most probable explanation of the phenomenon lies in the colloidal properties of soils.

We have already mentioned the curious phenomenon of banded structure of the precipitate of silver chromate formed by the interaction of silver nitrate solution with potassium chromate in gelatin gel. It has been found that various other media, such as agar-agar and silicic acid gels also behave in the same way as gelatin. But the action of gels in bringing about periodic precipitation is specific. For example, silver chromate forms rings in gelatin, but not in agar-agar, while lead iodide gives these in the latter but not in the former. We have observed that ferric hydroxide gets precipitated in rings when a soluble ferric salt is present in silicic acid gel, and gets slowly acted upon by an alkali from above. Recently, Bhatnagar and Mathur (*Kolloid Zeit.*, 1922, XXX., 368-71) have been successful in preparing a number of different kinds of periodic precipitates in this gel.

No satisfactory explanation has yet been forthcoming for this interesting phenomenon, but as shown by Chatterji and Dhar (*Kolloid Zeitsch.*, 1922 XXXI.), peptisation plays an important part in the formation of banded precipitates. In almost all cases where banded precipitates are formed, the phenomenon of peptisation has also been noticed. The facts observed in connection with the formation of these banded precipitates may be summarised as follows:

(1) The phenomenon takes place in a gel in which one of the reacting substances is dispersed.

(2) The spaces above and between the rings are almost entirely free from the reacting substances.

(3) Complex organic matters of a colloidal nature help the taking place of the phenomenon.

If we compare the above facts with those that have been set forth before in the case of pan formation, the similarity becomes at once obvious. The formation of pans in soils is in all probability another example of periodic precipitation on a large scale in nature. At first the soluble salts of iron and aluminium are present in a state of solution throughout the mass of a medium of silicic acid gel. The gel is, of course, formed from the silicic acid sol resulting from the gradual disintegration of rocks by

rain water and their colloidal dispersion. The alkali, naturally present in the soil, or *ammonia formed from the organic matter*, begins to react with the salts of iron and aluminium producing the insoluble hydroxides, which get precipitated in rings or narrow bands in the silicic acid medium. In course of time the silicic acid gel dries up and gives rise to the typical open texture sandy soil, consisting of quartz grains, the zones of ferric and aluminic hydroxide precipitates forming hard, compact masses, commonly known as "pan."

If this view about the formation of pans in soils is more or less correct, we can easily assign reasons for a number of facts which have been observed in connection with this phenomenon, and which have previously been overlooked. Thus if we scrutinise the analytical figures given above for the pan-bearing soil, it would be found that the iron and aluminium contents of the soil below the pan are much higher than those above, so that there seems as if there is not one layer of pan, but several layers of it close to one another. This is what is expected from the point of view of periodic precipitation. Again, pan-bearing soils are rich in organic matter, and as has been said before, the presence of this considerably enhances the peptising power of the medium and helps in the subsequent formation of banded precipitates. The almost entire absence of calcium carbonate from the soil cannot at present be more satisfactorily accounted for, beyond the fact that the periodic precipitation of substances are specific in nature and that calcium hydroxide or carbonate does not bring about the preliminary peptisation of iron or aluminium hydroxides in silicic acid gel.

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FARMING METHODS IN NORTHERN MANCHURIA.

(Journal of the Royal Society of Arts, July 20, 1923.)

Northern Manchuria is pre-eminently a country of small landowners. The landowner himself works his fields in the majority of cases, but the larger landowners often turn their farms over to tenants.

The division of the land into small parcels and the low purchasing power of the individual farmer have been serious drawbacks to the introduction of modern farming machinery, and Chinese conservatism and loyalty to traditions have also been opposed to new methods of farming. In a district covering an area of approximately 250,000 square miles there are, according to information furnished by one of the large dealers in agricultural machinery, only about 300 ploughs of the American type and some 500 German Sack ploughs. There are only 300 disc harrows, and very few mowers, reapers, and self-binders. Even these are not Chinese owned, but belong to Russian farmers who have settled in the zone of the Chinese Eastern Railway.

In Northern Manchuria, according to a report prepared in the American Consulate at Harbin, the land is very carefully worked, great attention being paid to fertilisation. The land is ploughed in parallel ridges and furrows. The soil is worked twice, which enables the roots to draw moisture from the night air, even in time of drought.

The plough used is very primitive. Into a wooden frame is set a spade-shaped ploughshare, which is clamped to the bent wooden lever or beam. The other end of this lever serves as a handle, and at the middle of it is fastened a grader. The ploughshare is held in almost a perpendicular position to the surface of the land and tears it effectively. This plough is usually drawn by two animals (horses, mules, or oxen), and is attended by two labourers, one of whom guides the plough and the other the animals. It is transported to and from the field on a special wooden drag.

There are two methods of ploughing the soil. Either the ploughshare follows the ridge, and where last year there was a ridge there will be a furrow this year, or the ploughshare follows the furrow, and where last year there was a furrow there will also be a furrow this year.

Sowing or seeding is seldom performed by hand, the use of a "chan hu lu" being more popular. This is a dried pumpkin, which has an opening made in the narrow end. The pumpkin is filled with seeds and the opening is then closed with a cork, into which is fitted either a reed or some kind of piping in such manner that the seeds will scatter if the instrument is slightly tipped and lightly tapped with the hand. One workman, carrying the "chan hu lu," walks along the furrow, and tapping the pumpkin with his right hand, he scatters

the seed so that they fall on the ridges. Another man, walking along the ridge, stamps the seeds down with his feet. Behind them follows a third man, with a horse which pulls a small stone roller. This roller follows the two ridges. On the new ridge it levels out the crest, and on the other it smooths out the tracks of the second labourer's feet and covers the seeds with earth.

When weeds begin to appear the Chinese farmer once more follows along the furrows with his plough, deepening them by half a foot so as to surround the sprouts with fresh earth. When the sprouts have reached considerable height the plough is again used for bringing the deeper roots closer to the surface, thus enabling them to absorb more moisture from the air. By this process weeds are also destroyed between the ridges. On the ridges themselves weeding is done by means of hoes.

For the harvest of cereals the Chinese farmer uses a special scythe, which is similar to the American scythe but of smaller dimensions. Very few Chinese farmers in Northern Manchuria are familiar with flails. In threshing, the plants are placed in a circle, with heads toward the centre, and over these is drawn by animals a heavy stone roller. Before the kaoliang is threshed, however, the heads are cut off from the stalks to prevent these being spoiled by the roller, for the kaoliang stalk plays an important rôle on the farm, inasmuch as it is used for roofing, fencing, fuel, and many other purposes. The roller process is continued until all the grains have been removed. Winnowing is done with shovels and old-fashioned hand sifters.

The threshed and cleaned grain is stored either in pits or in specially constructed cylindrical silos, covered with a conical roof. These silos vary in size according to the requirements of the individual farm. They are built of poles, which are plaited with dry twigs, the whole structure being plastered inside and outside with a composition of clay and straw cuttings. It is divided into two or three compartments for the different kinds of cereal. Besides these silos the Chinese employ so-called "chantze." These resemble wells and are made of boards.

The threshed grain is ready for the market and for the feeding of cattle. For preparing human food, however, it is necessary that the hulls be removed. This is done by the "chantze"—a round, stationary, horizontal millstone, upon which rotates a stone cylinder with a rough surface. This cylinder is usually moved by small donkeys.

The Chinese plough is particularly unsuitable for breaking new ground, and this is one reason why the Chinese farmer is reluctant to take up virgin land. Some years ago the Government conceived the idea of ploughing up large tracts of land in order to sell them to immigrants from the south. It is believed the plan fell through because of some unfortunate financial manipulation in connection with the purchase of machinery. It seems, nevertheless, that this idea may be revived by some enterprising manufacturer, with a view of introducing modern farming machinery on a large scale through the agents of the Government. There appears to be a tendency at the present time to encourage immigration into the Nonni Valley and other parts of Heilungchiang Province.

The Chinese Eastern Railway, which maintains two agricultural experiment stations in the district—one of 300 acres at Station Anda, and one of 250 acres at Old Harbin, together with an experimental farm of 700 acres at Station Echo—appropriated 60,000 gold roubles for farming experiments during the year. The representative of a large American firm has been conducting tractor trials on these grounds, and they are generally reported to be exceptionally satisfactory. Two tractors are being experimented with—one pulling two-bottom ploughs and the other pulling four-bottom ploughs. This representative is of the opinion that the future of these tractors in Northern Manchuria is most encouraging.

The market in Northern Manchuria appears to be worthy of study on the part of manufacturers of agricultural implements, especially the smaller type of implements, such as ploughs, cultivators, seeders, threshers, and fanning mills.

THE PREPARATION OF STIBINE FROM ALLOYS.

By Edward J. Weeks, M.Sc., F.C.S.

Various workers have given the percentage composition of alloys of zinc and antimony best suited for the preparation of stibine, but if these results are summarised

no agreement is found among them. Thus we find the following alloys given:

	Parts of Zinc.	Parts of Antimony.
L. Thompson, *Phil. Mag.*, 1837, (3), 10, 353	1	1
K. Olsgewski, *Monatsh. Chem.*, 1886, 7, 371	1.5	1
Berthelot & P. Petit, *Compt Rendus*, 1889, 108, 546 ...	2	1
A. Stock & W. Doht, *Ber.*, 1901, 34, 2339	4	1
A. Stock & W. Doht, *Ber.*, 1902, 35, 2270	4	1
	2.5	1

In 1889 Berthelot and P. Petit (*loc. cit.*) stated that no stibine is obtained unless 5 *atoms of zinc are present to one atom of* antimony. This gives 1 part by weight of antimony to 2.8 parts of zinc.

It is noticed from the above that A. Stock and W. Doht give as the best alloy 2.5 parts of zinc to 1 part of antimony, or 1.35 atoms of zinc to 1 atom of antimony. This does not agree with the statement by Berthelot and P. Petit, and indeed these workers themselves state that stibine may be prepared from an alloy of 2 parts of zinc to 1 of antimony, or 1.09 atoms of zinc to 1 atom of antimony, an experiment which does not agree with their own statement.

We must, therefore, conclude that there is no actual best composition of the zinc, antimony alloy for the preparation of stibine, but that the same amount of stibine may be obtained from any alloy of composition varying from 1 part of zinc to 4 parts of zinc to 1 of antimony.

Sir John Cass Institute,
Jewry Street.
2/8/23.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE INSTITUTE OF METALS.

Autumn Meeting, Manchester, September 10 to 13, 1923.

A very full programme has been arranged, including visits to important works. On the evening of the first day, a lecture will be given by Lieut.-Colonel Sir Henry Fowler, K.B.E., on *The Use of Non-Ferrous Metals in Engineering*, and during the meeting the following communications are expected to be submitted:

E. A. Bolton, M.Sc., Birmingham, *The Cause of Red Stains on Sheet Brass.*

H. W. Brownsdon, M.Sc., Ph.D., F.I.C. (Member of Council), *Note on Brinell Hardness Numbers.*

H. I. Coe, M.Sc., Swansea, *The Behaviour of Metals under Compressive Stresses.*

Hikozo Endo (Sendai, Japan), *On the Measurement of the Change of Volume in Metals during Solidification.*

Ulick R. Evans, M.A., Cambridge, *The Electrochemical Character of Corrosion.*

Marie L. V. Gayler, M.Sc., Teddington, *The Constitution and Age-Hardening of the Quarternary Alloys of Aluminium, Copper, Magnesium, and Magnesium Silicide.*

D. Hanson, D.Sc., C. Maryatt, B.Sc., and Grace W. Ford, B.Sc., Teddington, *Investigation of the Effects of Impurities on Copper. Part I.—The Effect of Oxygen on Copper.*

Douglas H. Ingall, M.Sc., Wednesbury, *Experiments with some Copper Wire: Cohesion a Function of both Temperature and Cold-work.*

A. H. Mundey and C. C. Bissett, B.A., B.Sc., B.Met., London, *Note on The Effect of Small Quantities of Nickel upon High-Grade Bearing Metal.*

A. H. Mundey and John Cartland, M.C., M.Sc., London, *Stereotyping.*

Hugh O'Neill, M.Met., Manchester, *Hardness Tests on Crystals of Aluminium.*

Albert M. Portevin, Paris, and Pierre Chevenard, Impby, *A Dilatometric Study of the Transformations and Thermal Treatment of Light Alloys of Aluminium.*

R. C. Reader, Ph.D., M.Sc., Birmingham, *Note on Effects of Rate of Cooling on the Density and Composition of Metals and Alloys.*

E. L. Rhead, M.Sc.Tech., and J. D. Hannah, Manchester, *Crystallisation Effect on Galvanised Iron Sheets.*

Professor P. Soldau, Petrograd, Russia, *Equilibrium in the System Gold-Zinc (based on Investigations of Electrical Conductivity at High Temperatures).*

Full particulars can be obtained from the Secretary, G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

THE BRITISH CHEMICAL AND DYESTUFFS TRADERS 'ASSOCIATION.

The Committee of the above Association have forwarded a memorandum from H.M. Treasury, containing proposals that it is suggested may lead to increased shipments of chemicals from this country—as the matter seems to us to be of special importance, we reproduce it in full below:—

[Copy.]

Memorandum from The British Chemical and Dyestuffs Traders' Association on the method of payment of duties under The Safeguarding of Industries Act, 1921—Part I.

Importers of goods scheduled under Part I. of The Safeguarding of Industries Act, 1921, have to pay the duty of 33⅓ per cent. at the time the goods are landed and cleared at H.M. Customs.

This procedure, it is understood, is governed by Section 39 of the Customs Consolidation Act, 1876, whereby H.M. Treasury are given power to decide whether goods liable to import duties shall be allowed to be bonded or not.

The Treasury Order in respect of The Safeguarding of Industries Act, 1921, stipulated that the duties should be paid at the time of landing and clearance of the goods at H.M. Customs.

During the period this Act has been in orce it has been found that the present method of payment of duties as outlined above is, in many ways, having a detrimental effect on the commerce of this country. The following points are submitted in support of this view:

1.—Prior to the introduction of The Safeguarding of Industries Act and the import duties it entails, merchant importers were in the habit of holding as stocks bulk supplies of goods, and were thus enabled to meet both home and overseas demands without delay. The re-exportation aspect was then of very considerable importance, it being estimated that quite half the volume of imports now liable to Key Industry duty were, when previously allowed free import, disposed of by way of re-export sales. Careful and exhaustive enquiry has been made as to what effect the payment of import duties under the Act has had on this important branch of the chemical trade, and it has been found that:

(*a*) The difficulties and uncertainty of obtaining "drawbacks" of duties paid at the time of importation make it impracticable for merchants to compete in overseas markets. For instance, unless a merchant holding stocks of goods on which duty under this Act has been paid can ascertain definitely and quickly whether he can recover such duty upon re-exportation, he is unable to arrive at his selling price, and is thus prevented from competing for overseas business. It is certain that if he does not allow for a "drawback" his price to the foreigner would not be competitive.

(*b*) That on account of this position the volume of re-exports of goods liable to Key Industry duty has fallen away in a very deplorable manner, and merchants are continually complaining that they have, and still are, losing such business, and state that it is largely due to the disadvantages arising out of the present method of collection of duties levied under the Safeguarding of Industries Act, 1921, Part I.

(*c*) Some firms, in an endeavour to overcome this barrier to re-export trade, are now holding stocks at Continental ports and meeting demands in that way. This must entail loss of freights to the shipping interests of this country; loss of employment at the docks, in warehouses, and in various other directions. It has been found that in this way only is it possible and practicable for merchants in this country to hope to compete successfully in overseas markets.

(*d*) Claims for drawbacks usually take a considerable time to settle, and in many instances where the goods in question have, since their importation, changed hands one or more times, it has been found almost impossible to satisfy H.M. Customs as to their identity. While the merchant is attempting to overcome these difficulties the overseas business is lost.

2.—As regards sales of dutiable goods in this country, merchants, in order to carry on their business as economically as possible and to fulfil their function as distributors, are in the habit of importing in bulk

quantities. Such goods are gradually liquidated, and in many instances the duty paid at the time of importation may not be recovered in full for twelve months, or even longer. For instance, the importer of dutiable goods to the value of £3,000 has to pay £1,000 as duty at the time of importation, and it is not exceptional for the period mentioned to elapse before the whole of the importation is sold and the duty thus recovered. In this way considerable amounts of capital are locked up, to the detriment of the merchant and trade in general.

It is submitted that, in the case of re-exports, if merchants were given the opportunity of putting goods liable to Key Industry duty into bonded warehouses at the time of importation and thus be relieved of the immediate payment of duty and the uncertainty of obtaining drawbacks, the trade of this country in re-exports of chemicals would be materially facilitated, and would undoubtedly increase in volume.

In the case of sales to buyers in this country, duty would only be paid at the time they were taken out of bond for actual delivery. Under this arrangement comparatively large amounts of capital would be at the importers' disposal, instead of being locked up, as is the case under the present conditions.

Consideration has been given, and enquiry made, as to whether there would be objection on the part of warehouse interests to accepting goods scheduled under Part I. of the Safeguarding of Industries Act, on account of their dangerous character in themselves or when stored with other goods. It appears that as these materials are packed in such a manner as to satisfy shipping lines, who accept them at ordinary rates, and, for the same reason, insurance of such goods is effected at low rates, it is believed that warehouse interests would approve of the suggested system of bonding.

It is therefore suggested that, as the present system of collection of duties under the Safeguarding of Industries Act, 1921, Part I., is doing great harm to the commerce of this country, especially in the matter of re-exports, the Order made by H.M. Treasury at present in force should be suitably amended so as to allow dutiable goods to be put into bond.

Forwarded to H.M. Treasury, and copy to H.M. Customs.

B. C. and D. T. A., London, 4th August,

THE BRITISH CAST IRON RESEARCH ASSOCIATION.

Monthly Circular.

JUNE, 1923. No. 19.

RESEARCH DEPARTMENT.

PROGRESS OF RESEARCH IN HAND.

Shrinkage Defects Research. — Experimental castings are continually being made in various foundries. These are being tested under conditions to obtain definite data in respect of chemical and physical properties. Important results bearing upon draws and shrinkages are being obtained.

Foundry Sand Research.—Important arrangements are being made for carrying out a thorough investigation upon foundry sands. The work will probably be done at the Birmingham University, and in one of the large foundries. The bureau are issuing a complete bibliography of sand literature.

Cast Iron to Resist Sea Water.—A Joint Research with the Electrical Research Association is being arranged to carry out this important work. It is estimated that the experimental work will occupy about two years, and will be carried out at the coast and in tidal rivers. The results of such work will be very beneficial to the electrical industry and our own members.

Internal Combustion Engine Castings.—This research, carried out jointly by this Association, the Motor Research Association, and the Motor Cylinder Research Association, is reaching a stage when some beneficial results should accrue. Engine cylinders made in this country and abroad have been examined and reported upon. Test castings to variable specifications have been made, and are now being subjected to test.

Cast Iron Moulds for Bottle Making.—This joint research with the Glass Research Association is progressing, and test moulds are now being experimented upon and tried in special bottle making machines.

Malleable Cast Iron Research.—It should not be necessary to report every month that the progress of this very important work is hampered by the lack of support given by the malleable industry. Malleable iron-

founders should call a conference and discuss the position of their industry. The Bureau Bulletin gives a complete bibliography of the literature upon malleable iron as published since 1722, which is very interesting reading.

Standard Specification for Grey Iron Castings.—The Association considers that the time has arrived when a standard specification for grey iron castings should be drawn up, and steps have been taken to have this carried out in conjunction with the B.E.S.A.

PROBLEMS SENT IN BY MEMBERS.

Members, during the past month, have sent in problems for the Director's advice upon the following: Porosity in cylinder castings; defects in pump castings; defective pig iron; annealing malleable iron; liners for semi-Diesel engines; C.I. bevel wheels; Cupola design; pumps for sea water; pin-holes in malleable C.I.; shrinkage in castings; malleable annealing ovens; C.I. valve guards; glass bottle moulds; defects in heavy castings; stripping plate patterns; porosity in malleable castings.

THE BUREAU AND LIBRARY.

Further books and papers have been presented to the library during the month The library, which has been closed for the cataloguing work, is now reopened for issue of books.

The following new foundry book has been sent for review in the next bulletin:

Pattern Making, by McCracken and Sampson. Published by Scott Greenwood & Son.

All new books are reviewed in the Bulletin, and members should consult same.

MEMBERSHIP.

The gradual increase in the membership is very gratifying. The increase during the past month has been exceptionally good, and places the success of the Association's future work beyond doubt. With trade improving, ironfounders are recognising the necessity of membership, and it only needs the present number to be very materially increased to enable the larger research works to be commenced.

SUGGESTIONS FOR RESEARCH.

Members have assisted the Research Committee by making suggestions for research to be carried out. These have been of very great value. The field for foundry research is so great, there are so many problems to attack, that members should advise the Association as to the problems they consider are of the most urgent importance to the industry. Very effective co-operation can thus take place.

Take, for instance, Cupola practice: the Association has assisted a large number of members in their Cupola melting methods, yet it is very remarkable to find the very variable conditions under which this is carried out; there is no standardised practice. Here is a wide field for work by the Association and of vital interest to every grey iron founder in the country, and yet, due either to apathy or to the peculiar foundry conservation, he holds out in joining the Association and obtaining its advice.

INTERNAL COMBUSTION ENGINE CYLINDER RESEARCH.

"The continued examples of failure of metal, not necessarily confined to the marine Diesel engine industry, seem to indicate that metallurgical science either has not reached the high standard which we have lately been accustomed to believe, or the results of investigation in working practice and in experimental research are not communicated in a sufficiently extensive manner to those concerns immediately or indirectly interested. In the case of Diesel engine construction it appears particularly advisable that no efforts should be spared in the direction of further research, and, what is of vital importance, the publications of specifications of alloys, records of experiments with relation to the behaviour of metals in high temperatures, and data referring to wear of parts.

"We believe that much time and labour could be saved if there were more co-operation between marine Diesel engine builders, particularly with regard to their experimental sections. Undoubtedly, with such involved subjects demanding investigation, collaboration would benefit the largest concerns equally with the smallest. Definite standards could be set up, guess-work and rule of thumb practices abolished, and data of exceptional value afforded. With reference to specifications of metal, doubt as to the capabilities of certain types of cast-iron has led to a plethora of costly expedients, by which the designer, bringing to his aid constructional complications, aims at a result which should be attained by more

direct and simple means. The present work of the British Cast Iron Research Association should be valuable in this direction." -(*Motor Ship*, June, 1923.)

Central House, New St., Birmingham.
THOS. VICKERS, *Secretary*.

ROYAL INSTITUTION OF GREAT BRITAIN.

WEEKLY EVENING MEETING, FRIDAY, MAY 4. 1923.

SIR JAMES CRICHTON-BROWNE, M.D., LL.D., F.R.S., TREASURER AND VICE-PRESIDENT, IN THE CHAIR.

THE ORIGINS OF THE CONCEPTION OF ISOTOPES.

A Lecture delivered by Frederick Soddy M.A., F.R.S.

One of the most important consequences of the study of the chemistry of the products of radioactive change has been the discovery of isotopes and the interpretation in consequence of the Periodic Law in terms of modern views of atomic structure. It is one of the few fields in the vast borderland between physics and chemistry, overrun of recent years by an advancing swarm of mathematicians and physicists, armed with all sorts of new-fangled weapons, in which the invaders have found the chemist already in possession. The broad highways they have hewn thereto are already dusty with the tread of pilgrims, and are being watered by the tears of candidates for "Honours." But the somewhat intricate bye-ways through which the chemist first found his way into this virgin territory, and the views on the road before it was in sight, may still preserve something of their pristine interest.

The word *isotope* signifies "the same place," in allusion to isotopes occupying the same place in the Periodic Table. Before this word of theoretical meaning was coined, isotopes were experimentally well known as elements non-separable by chemical methods and completely identical in their whole chemical character. The analysis of the constituents of matter, to which we were born and brought up to regard as the most searching and fundamental, is an analysis by means of its chemical properties. Although, later, a new and even more powerful method, spectroscopic analysis, was developed, it merely dotted the *i*'s and crossed the *t*'s of chemical analysis, filled in a few vacant places in the Periodic Law, and handed over the newcomers to the chemist to classify along with the rest of the eighty or so "foundation stones" of which he supposed the material universe to be built up. Then, with the close of last century, another new method, radioactive analysis, was developed, which is applicable of course only to the radio-elements—that is, to the elements uranium and thorium and the thirty-four, as we now know, successive unstable products of their spontaneous disintegration. Each of these possesses a definite radioactive character; it is produced from one and changes into another element, and, in both changes, rays characteristic of the two substances are expelled, which are as fine a hall-mark of their identity as any of the "tests" of chemical analysis. But radioactive character, unlike spectroscopic character, is completely independent of chemical character. The latter might be called "existence properties," whereas the radioactive character is that attending the explosion of the atom which terminates the existence of the element as such. It provided the necessary independent method of analysis capable for the first time of distinguishing between elements identical chemically and occupying the same place in the Periodic Table—*i.e.*, between isotopes.

THE EARLIER CHAPTER OF RADIO-CHEMISTRY.

Not a hint of this, however, was afforded by the earlier chapter of radio-chemistry. On the contrary, no development could appear more normal. Just as rubidium, thallium, etc., were detected by the spectroscope before anything of their chemistry was known, so radium was detected in pitchblende by its radioactivity in concentration thousands of times less than is necessary to show a single line of its spectrum. But with more concentrated preparations a new spectrum was discovered and then a new element, which was found to possess a chemical character entirely new and sufficing for its separation in the pure state from all other elements. As in the case of the elements discovered by the spectroscope, radium was found to occupy a place, hitherto vacant, in the Periodic Table. But as it happened radium is exceptional in this. Its chemical characte

was quite normal, and indeed could have been largely predicted beforehand for the missing element occupying this place. The development of the subject showed it to be but one of some thirty-four radio-elements formed from uranium and thorium. But there are not thirty-four vacant places in the Periodic Table to accommodate them.

Meta-Elements.

So far as I am aware, there is no anticipation, prior to the systematic study of the chemistry of the radio-elements, of the idea that there may exist different elements with absolutely identical chemical character. Sir William Crookes, it is true, once thought, though the idea has not survived more extended examination, that the properties of the elements, as we know them, might be a mean value, and that the individual atoms composing the element might differ in weight and chemical character continuously on either side of this mean. If so, more refined methods might serve to resolve the element into a collection of what he termed "Meta-Elements," possessing the main character of the original, but differing from one another to a slight extent. Misled by the phosphorescence spectra, which are now known to be characteristic of mixtures rather than chemically homogeneous substances, he thought at one time that he had been successful in resolving yttrium. But the present idea that elements may exist, absolutely the same in chemical nature and yet absolutely different in other properties, such as radioactivity and atomic weight, is totally distinct from this.

The Experimental Method that First Revealed Isotopes.

I venture to think that no more elegant extension of our methods of gaining new knowledge has ever been obtained than that which, in due course, was to reveal the existence of isotopes. The original observations, upon which the theory of atomic disintegration was first founded, were that thorium is continuously producing a new radioactive substance, thorium X, separable from it by precipitation with ammonia, but not with other precipitants, and, after separation, continuously re-forming again. The thorium X was short-lived, and changed again into a gas, the thorium emanation, for which the name thoreon has recently been proposed, which was even shorter-lived and changed again to a solid, the "excited activity," now known as the active deposit, which again went through further changes. The rays resulted from these successive changes, α-rays in the first, and α-, β- and γ-rays in the last changes. Below is the first part of the thorium disintegration series as it appeared to Sir Ernest Rutherford and myself in 1903:—

$$\text{Thorium} \xrightarrow{\alpha} \text{Thorium X} \xrightarrow{\alpha} \text{Thoron} \xrightarrow{\alpha} \text{etc.}$$

In 1905, Sir William Ramsay and O. Hahn were engaged in extracting radium from thorianite, a new Ceylon mineral containing both uranium and thorium in important quantities. The radium was separated with the barium, and the chlorides fractionated in the usual way. They found a new radio-element to be present, and to be separated from the radium with the barium. It proved to be the direct parent of thorium X, and intermediate in the series between the latter and thorium, and they called it radiothorium. In spite of this easy and apparently straightforward separation, the experience of a number of chemists showed that something remained to be explained, for it was found to be difficult to the verge of impossibility to separate radiothorium from thorium. Ramsay and Hahn had in fact "separated" isotopes in 1905, for radiothorium and thorium are isotopes. Yet further work has shown the two to be so alike that no separation by chemical means is possible!

Then in 1907, along with the radium which had been separated from thorianite, Hahn discovered another new radio-element, mesothorium, the direct parent of radiothorium and intermediate between it and thorium. In the next year he showed that mesothorium consists of two successive products—the first, the direct product of thorium, mesothorium 1, being practically rayless and generating a short-lived product, mesothorium 2, giving powerful β- and γ-rays.

This resolved the mystery, and one cannot do better than to quote the words of McCoy and Ross (*J. Amer. Chem. Soc.*, 1907, XXIX, 1709):

"Our experiments strongly indicate that radiothorium is entirely inseparable from thorium by chemical processes. . . . The isolation of radiothorium from thorianite and from pure thorium nitrate . . . may have been accomplished by the separation of mesothorium, which in time changed spontaneously into radiothorium."

Thus the radiothorium separated from

the *mineral thorianite* by Ramsay and Hahn was *not* the *radiothorium in the mineral*, but that subsequently produced from the easily separated mesothorium, after it had been removed from the thorium. If they had fractionated the radium-mesothorium-barium mixture at once they would not have discovered radiothorium. The lapse of time after the separation of the mesothorium is essential. Nowadays many non-separable radio-elements are, like radiothorium, "grown" from their separable parents. Thus radium D, an isotope of lead, is grown from the radium emanation (radon), although it cannot be separated from the mineral, which always contains lead in quantity.

The first part of the thorium series now runs*:—

$$\underset{2.10^{10}\text{ years}}{\text{Thorium}} \xrightarrow{\alpha} \underset{9.67\text{ years}}{\text{Mesothorium 1}} \longrightarrow$$

$$\underset{8.9\text{ hours}}{\text{Mesothorium 2}} \xrightarrow{\beta}$$

$$\underset{2.91\text{ years}}{\text{Radiothorium}} \xrightarrow{\alpha} \underset{5.25\text{ days}}{\text{Thorium X}} \xrightarrow{\alpha}$$

$$\underset{78\text{ seconds}}{\text{Emanation}} \xrightarrow{\alpha} \text{etc.}$$

In this series thorium and radiothorium and mesothorium and thorium X are two pairs of isotopes. If we represent the successive products by balls of different colours to indicate their chemical character, isotopes being of the same colour, chemical analysis will sort the balls into their different colours, and the lapse of time will cause some of the colours to change. The ball representing mesothorium will in time turn into that representing radiothorium, so that the latter, before indistinguishable from thorium, becomes known as a separate individual.

The Isotopes of Uranium.

It will be noted that the method of separating isotopes depends upon their being alternate rather than successive in the series. If radiothorium had been the direct product of thorium, the two would never have been separated to this day. The changes of chemical character are, as we shall later see, intimately connected with the electric charges on the α- and β-particles expelled. For successive products to have the same character no rays, or at least no charged particles, must be expelled. It is always as well—and no subject illustrates the point better than that of isotopes—to reflect not only upon what our methods are able to reveal, but also upon what they cannot reveal.

At first it seemed as if uranium itself was a case of successive isotopes. Boltwood, in 1908, proved from his study of the relative activities of the successive products giving α-rays in minerals, that whereas all of them, except uranium, gave off only one α-particle per atom disintegrating, uranium gave off two. By direct observation with the scintillation method it was proved that the two α-particles from uranium are *not* simultaneously expelled, and later it was shown that they possess different velocities. If the slower comes from uranium itself (uranium I), the period of which is known to be 6.10^9 years, the swifter must come from the isotope (uranium II), and its period must be some three million years. This is *an example of isotopes being revealed by difference of radioactive nature simply* though no other evidence of their separate existences is available. Owing to the long periods of the α-ray giving members of the earl ypart of the uranium series, it has been much more difficult to unravel than th thorium series. As a result of researche too numerous to detail, it has been con cluded *that the main series is almost er tirely analogous to the thorium series, an* runs:—

$$\underset{6.10^9\text{ years}}{\text{Uranium I}} \xrightarrow{\alpha} \underset{35.5\text{ days}}{\text{Uranium }X_1} \xrightarrow{\beta}$$

$$\underset{1.65\text{ minutes}}{\text{Uranium }X_2} \xrightarrow{\beta}$$

$$\underset{3.10^6\text{ years}}{\text{Uranium II}} \xrightarrow{\alpha} \underset{10^5\text{ years}}{\text{Ionium}} \xrightarrow{\alpha} \underset{2440\text{ years}}{\text{Radium}} \xrightarrow{\alpha}$$

$$\underset{5.55\text{ days}}{\text{Radon}} \xrightarrow{\alpha} \text{etc.}$$

Though two short-lived products probal intervene between the two uraniums, a1 logous to the two mesothoriums betwe thorium and radiothorium, the relation their period to that of their product, u nium II, is so hopelessly unfavourable t

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* *The periods shown in the second line are the periods of average life of the successive products. These are 1.443 times the period required for one-half of the element to change.*

there is no hope of ever being able to put the separate existence of uranium II into evidence in the same way as was done for radiotorium. For all *practical* purposes the two uraniums are as non-separable by this method as if they were actually successive products. I spent many years, before this part of the series was at all well known, looking for the product of uranium X, and separated this constituent from 50 kilograms of uranium nitrate repeatedly in the attempt. I was looking for a growth of α-rays concomitantly with the decay of the β-rays of the uranium X. If the product had been ionium, as at first thought (U I $\xrightarrow{\alpha}$ U II $\xrightarrow{\alpha}$ U X $\xrightarrow{\beta}$ Io $\xrightarrow{\alpha}$), it should have been just possible to detect it. But since it is the thirty times longer-lived uranium II, the attempt is hopeless, especially as uranium X and ionium are isotopes, and therefore the uranium X separated must always possess a certain initial α-activity due to ionium.

The Absolute Chemical Identity of Isotopes and its Implications.

The years 1908-1910 were productive of many prolonged and serious efforts to separate isotopes by chemical means. In 1908 Boltwood discovered ionium, and showed that it resembled thorium. Keetman, who with Marckwald discovered ionium independently, tried twelve good methods, all known to be effective, in the purification of thorium in the attempt to separate the ionium from thorium, completely without success. Auer von Welsbach, on a technical scale, separated the ionium and thorium from 30 tons of pitchblende, and tried fresh methods in the hope of separating them, but failed. It was with this preparation that Exner and Haschek tried without success to find the ionium spectrum, and Russell and Rossi confirmed their result, that the spectrum was that of pure thorium. When later I had determined beyond doubt, from measurements of the rate of growth of radium from uranium, that the period of ionium was 100,000 years, and that Welsbach's preparation must have been approximately 30 per cent. ionium and 70 per cent. thorium by weight, it followed that the spectra of isotopes must, like their chemical character, also be identical. The difference, if any exists, is almost beyond the limit of detection by the most powerful methods.

(To be Continued.)

£15,000 DONATION TO IMPERIAL COLLEGE OF SCIENCE.

It is with pleasure that we are able to record an offer by the Clothworkers Company of the City of London of an annual contribution of £3,000 for the period of five years, 1923-1927, to the Governing Body of the Imperial College of Science and Technology, South Kensington, to be applied towards the maintenance and development of the City and Guilds (Engineering) College, one of the three constituents of the Imperial College of Science. This donation is supplemental to the sum voted some years ago by the Goldsmiths' Company, a gift amounting to £85,000, which enabled the Engineering College to extend its premises, and is quite distinct from the annual vote of £5,000 from the City and Guilds of London Institute, which has been paid to the Imperial College since the Charter was granted some fifteen years ago and applied to the City and Guilds (Engineering) College. It is another indication of the value which practical men in the City of London attach to the research and general teaching in science, specially in relation to industry.

BOOKS RECEIVED.

Landolt Börnstein, Physikalisch-Chemische Tabellen, by Dr. Walther A. Roth und Dr. Karl Scheel. 2 Vols. Pp. XV. + 1695. 1st Ed., 1923. Verlag von Julius Springer, Linkstrasse 23-24, Berlin, W.9.

The Discovery of the Nature of the Air and of its Changes during Breathing, by Clara M. Taylor, M.A. Pp. IX. + 84. 1st Edition, 1923. Messrs. G. Bell & Sons, Ltd., York House, Portugal St., London, W.C.2. 1s. 6d. net.

Materie Elektrizität Energie, by Dr. Walther Gerlach. Pp. 195. 1923. Verla gvon Theodor Steinkopff, Dresden und Leipzig.

BULLETINS PUBLISHED BY THE U.S. DEPARTMENT OF THE INTERIOR.

Cadmium in 1922, by C. E. Siebenthal and A. Stoll.

Petroleum in 1919-1921, by G. B. Richardson.

Natural Gas in 1919-1921, by R. S. McBride and E. G. Sievers.

732: *Geology and Ore Deposits of Shoshone County, Idaho*, by JOSEPH B. UMPLEBY and E. L. JONES, JUN. Pp. V. + 156.

740: *Mica Deposits of the United States*, by DOUGLAS B. STERRETT. Pp. XI. + 342.

741: *The Jarbidge Mining District, Nevada, with a Note on the Charleston District*, by FRANK G. SCHRADER. Pp. V. + 86.

743: *Geology of the Oatman Gold District, Arizona: a Preliminary Report*, by F. L. RANSOME. Pp. IV. + 58.

WATER-SUPPLY PAPERS.

488: *The Floods in Central Texas in September, 1921*, by C. E. ELLSWORTH. Pp. IV. + 56.

493: *Hydroelectric Power Systems of California, and their extensions into Oregon and Nevada*, by FREDERICK HALL FOWLER. Pp. XLIX. + 1276.

NOTICES OF BOOKS.

La Tannerie au Maroc, par CH. ZEIGLER. Pp. 122. Paris: Edité par "La Chaussure Française," Boulevard Sebastopol. 1923. Price 7fr. 50.

The native leather trade in Morocco ha always been prosperous, cattle rearing being a simple matter, and various vegetable bodies suitable for tanning are to be found near to hand. The processes are still conducted in a primitive manner, almost identical with those employed in England during the seventeenth and the beginning of the eighteenth centuries. The French have, however, recently introduced certain improvements.

Three kinds of tanning bodies are used. viz., crudely crushed oak bark, Tizra (*Rhus pentaphylla*), and Takaout (the gall of *Tamarix Articulata*).

The Tizra is a tree which seldom attains more than eight feet, but the bark of the trunk contains about 13 per cent. of tannins. The bark of the roots and branches is also used.

Several varieties of tamarix gall are known, and usually contain 40 per cent. of tanning matter. It is used especially for sheep and goat-skins.

The bark of three species of oak, *Quercus suber*, 2. *ilex*, and 2 *coccifera*, are also employed. Certain other native plants are ... having slight application.

For making leather, the skins are first depilated by immersion in several baths of milk of lime of increasing strength. They are then thoroughly washed and scraped, and it is customary to steep the skins for a week in water, to which dried figs have been added. The sugar present in this bath is supposed to give a suppleness to the leather. The actual tanning is then conducted in a bath of one or other of the bodies mentioned, and lasts about three or four days.

The processes throughout are most unhygienic, and are usually carelessly conducted. Further, although the leather so produced can be of a high quality, its value is often diminished by faults in the skin, due to careless killing of the beasts, and sometimes to the presence of parasites.

The author has described the preparation of the skins and their sale in the markets, and gives other details of general interest, together with numerous photographs and some coloured illustrations of native shoes.

J.G.F.D.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5. Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

18573—Ostro-Products Corporation of America.—Manufacture of medical preparations containing arsenic. July 16.

18574—Ostro-Products Corporation of America.—Manufacture of paraoxymetanitrophenylarsenious acid. July 18.

18362—Carbide & Carbon Chemicals Corporation.—Purifying chlorine, &c. July 16.

18439—Naugatuck Chemical Co.—Process for halogenating latex, &c. July 17.

18552—Shimadzu, G.—Manufacture of powder of lead suboxide intermingled with powder of metallic lead. July 18.

Abstract Published this Week.

198576—Metaldehyde. *J. Y. Johnson, 47, Lincoln's Inn Fields, London.*

Metaldehyde is produced by the action of the *following catalysts* on acetaldehyde at temperatures below 10° C., (1) titanium chloride, (2) a bromide of an alkali or alkaline-earth metal, such as lithium or calcium bromide, (3) a halide of an alkali metal, alkaline-earth metal, aluminium, zirconium, thorium, cerium, lanthanum, yttrium, ytterbium or titanium, in conjunction with an acid, such as hydrochloric or hydrobromic acid, an acid salt, or a compound having acid properties, such as ferric chloride, aluminium chloride or sulphur and antimony haloids.

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THE CHEMICAL NEWS,

VOL. CXXVII. No. 3305.

SIR WILLIAM CROOKES' ANTI-GLARE GLASSES.

By J. H. Gardiner, F.Inst.P.

I suppose that I have the privilege of knowing as much as anyone about this subject, having been intimately associated with the late Sir William Crookes for more years than I care to count, working under him in all the researches connected with the glasses that bear his name. Sir William was deeply interested in the subject, and was engaged upon the work at the time of his death.

A few words briefly giving the history of the research may not be out of place. The work on the radiation transmission of transparent substances began with an enquiry into the cause of glass-maker's cataract, and several years of hard work were devoted to it; in 1914 a paper was read before the Royal Society in which formulæ were given for many glasses having special optical properties, and manufacturers were encouraged to produce them for general use. As a result, Sir William was inundated with enquiries from private people needing assistance for eyesight trouble, and from glass manufacturers who wished to use his name for glasses that they had succeeded in making from his published formulæ.

It soon became evident that further work was necessary to produce a glass that would absorb as much ultra-violet radiation as possible, and at the same time transmit the bulk of the visible rays; the glass also had to be pleasing in appearance. It was evident that it would be necessary to make a variety of tints to suit different climatic conditions.

The work was carried out with the assistance of Mr. Harry Powell, of Whitefriars Glass Works, whose death unhappily occurred a few days ago. Agreements were made between Sir Wiliam and Mr. Nelson Wingate, of Wigmore Street, W., for the glasses to be placed upon the market as soon as conditions made their production possible. Some of these glasses are on exhibition here to-night. Many causes, that I need not enter upon now, have prevented very large production, but it is hoped that the output will be increased shortly; the glass is of a very special character, and presents unexpected technical difficulties.

On the death of Sir William the whole of the data for the preparation of the glasses, and the apparatus that had been devised for obtaining measurements of the radiation transmitted and absorbed by them, were given into my charge; the apparatus will shortly be erected at the Laboratories of the new Whitefriars Glass Works at Wealdstone, where we hope to be able to produce the material in larger quantities than has been possible at the old works in London.

Discussion.

Dr. L. C. Martin: I would like to draw attention to the work of Verhoeff and Bell on the "Pathological Effects of Radiant Energy on the Eye" (*Proc. Amer. Acad. Arts and Sciences*, July, 1916, LI., No. 13). A systematic review of the literature is given by Dr. C. B. Walker in the same issue. The authors show that the radiations possessing "abiotic" power (or power of destructive action on living tissue) are confined to wave lengths shorter than 0.305 μ. It is under exceptional conditions that such harmful action can be caused by sunlight which possesses very little energy at 0.305 μ and contains no wave lengths shorter than 0.295 μ at the earth's surface owing to atmospheric absorption. Similarly the possibility of abiotic action with the light from ordinary enclosed sources of artificial light is very remote, although with naked arcs, etc., special protection must be given.

In ordinary life the causes of eye strain and inflammatory conditions must be sought in conditions other than the abiotic action of light, and attention would be better directed to the regulation of the intensity of the visually apparent radiations, to general health, and to the provision of proper refractive correction. The conclusions set out in my paper on "Light Filters for Eye Protection" (*Trans. Opt. Soc.*, April, 1917, XVIII.) agree with those of Verhoeff and Bell, and I would like agrin to draw attention to that paper in the present connection.

Mr. H. H. Emsley: I associate myself with Dr. Martin to the extent of expressing some confusion of mind as to what exactly Crookes' glass is intended to do. My recollection of Crookes' work on the subject is that it was found that cataract in glassworkers' eyes was caused by the infra-red radiation and not by the ultra-violet. Nowadays one hears no word about the infra-red absorbing properties of the glass. It is true

that Crookes extended his investigation as he proceeded and encountered many difficulties, but I am not clear as to why the ultra-violet is continually referred to and practically nothing is stated about the infra-red.

(From "Transactions of the Optical Society," Vol. XXIV., No. 2, 1922-1923.)

SOME PROPERTIES OF THE META-PHOSPHATES OF SILVER.

By John Missenden, B.Sc., and F. E. Liechti.

The *di-salt*, which is mainly produced by the action of the nitrate upon an alkaline metaphosphate, is of a curiously hard crystalline structure, insoluble in water; nor is any water released from the substance by heating to dull redness. It is quite possible, however, to prepare a monohydrated *di*-salt (*i.e.*, the *monohydrated silver dimetaphosphate*, $Ag_2P_2O_6H_2O$) in the following reaction: Add to a solution of silver nitrate about one-half by weight of lithium disodium metaphosphate, and gently apply heat until evaporation has dispelled 30 per cent. of the water. The crystals will separate upon cooling.

In a similar way, the *monohydrated silver trimetaphosphate*, $Ag_3P_3O_9H_2O$, may be obtained from the action of the nitrate upon a concentrated solution of sodium trimetaphosphate. Some doubt was expressed as to the correct proportions of the constituents. A. Weisler[1] used three times as much of the nitrate as the trimetaphosphate, but C. G. Lindböm[2] was successful with an excess of the latter. The writers have found, however, that equal proportions give the best results; but a most interesting point is that far larger crystals can be obtained if the metaphosphate is in excess, although sodium comprises part of their content up to (and, in rare cases, over) 1.45 per cent. The monohydrated silver trimetaphosphate has been found to yield 64.2 per cent. of its water at 100° C., but reabsorbs the greater part from the atmosphere, and will not make a further yield when reheated to a similar temperature, although the whole of the water is lost upon liquefaction.

The *hexametaphosphate*, obtained in gelatinous white flakes, takes the formula, $Ag_6P_6O_{18}$, and is quite insoluble in water. It can be prepared, however, in a decided crystalline form, and may be divided into silver tetraphosphate, $Ag_6P_4O_{13}$, and an acid solution. Treatment with sodium sulphide produces sodium hexametaphosphate.

By the action of silver nitrate upon the *slightly soluble sodium dimetaphosphate*, a new compound, *silver decametaphosphate*, $Ag_{10}P_{10}O_{30}8H_2O$, is formed, which lost the greater portion of its water upon heating to 135° C. The most stable form of this compound is the tetrahydrated salt. The action of silver nitrate upon sodium hexametaphosphate gives two more compounds, *sodium pentasilver hexametaphosphate*, $NaAg_5(PO_3)_6$, and *disodium tetrasilver hexametaphosphate*, $Na_2Ag_4(PO_3)_6$. By using a potassium hexametaphosphate, $K_2Ag_4(PO_3)_6$ has been produced, but we do not believe that the potassium pentasilver salt exists.

W. Henneberg's theory that the interior of the grey viscid mass produced by the action of hot water upon silver hexametaphosphate is composed of *silver pyrometaphosphate*, $Ag_4P_2O_7Ag_2P_3O_6$, is well founded, but the mass only contains about 40 per cent. of this compound, the remainder being silver tetraphosphate, $Ag_6P_4O_{13}$.

A. V. Kroll[3] has discussed a series of the order $Ag_2O : P_2O_5 :: 1 : 2$ (and as 1 : 3). He has termed them the ultraphosphates. Little is known of this series.

FISH MEAL AND GUANO.

J. O'Sullivan.

Endeavours hitherto made for the manufacture of fish meal and guano have, in some cases only, when favoured by circumstances, given good results. The chief causes why manufacture has not been more widely adopted are: unsuccessful local attempts; high cost of plant; the low prices of the products and, especially, doubts as to which were the best methods. The question now presents itself in quite a different light. In the first place, the laws regarding destruction of refuse are very strict, and it is more expensive for those re-

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[1] *Zeit. anorg. Chem.*, 1901, XXVIII., 177.
[2] *Acta Lund.*, 1844, X., 7.
[3] *Ueber Ultraphosphate. Zeit. anorg. Chem.*, 1912, LXXVI., 408.

sponsible, and then the products, at the present time, realise relatively good prices. Moreover, it has been made possible to transform fish oil into solid fat by hydrogenation and sell it for various industrial purposes. The protein, after suitable treatment, can be utilised as food for animals (especially pigs), so that prices are quite likely to be higher than those for the guano. Finally, a number of engineering firms have undertaken a scientific study of this question, hitherto neglected.

From the technical point of view, the problem can be epitomised in one condition, viz., complete separation of the three component parts, water, fat, and dry matter. The simplest mechanical methods consist in treatment of the raw materials in a hydraulic press or under heated rollers. Results have not been satisfactory. In the first case the water and fat are not completely extracted, and the meal has to be subsequently dessicated. The following is an analysis of meal made with hot rollers which have the same inconvenience as presses:—

Whole Meal.—Crude protein, 58.29 per cent.; fat, 23.79 per cent.

Herring Meal.—Water, 8.32 per cent.; crude protein, 58.91 per cent.; fat, 14.02 per cent.

The percentage of fat is much too great, and this can only be employed as a fertiliser and not as food, which would give flesh and milk an oily flavour. The chemical methods are very numerous. Treatment with sulphuric acid, sulphuric saponification, is often adopted, and gives better separation of the fat than by boiling the materials in presence of sulphuric acid. After pouring off the fat the solid residue is neutralised, dried and crushed or treated with nitro-sulphate of calcium. Another method is boiling the fish waste under pressure, mixed with caustic soda. The cells are broken up and the fat saponified. The soap is obtained by precipitation, and the residue dried and crushed.

Finally, the materials are transformed into a fertiliser by aid of a potassium salt, to be then dried. The chemical processes have been but little studied from the constructive point of view, and the plant is generally very rudimentary. The chief defect is that the products are only fit for fertilisers and results of manufacture consequently less favourable. The process *by displacement* (solvents like benzine, carbon tetrachloride; and all derivatives of chlorine, methane and ethane) removes fat sufficiently, and gives a residue in form of a fertiliser, after drying and crushing. Consequently this method has acquired greater importance and been more carefully studied. Analysis of a meal made from haddock with benzine gave: water, 14.3 per cent.; protein, 58.55 per cent.; crude fat, 1.76 per cent.; dry residue, 15.67 per cent. Solvents, however, cause certain difficulties. The crude material is made impermeable by benzine, and must be treated on a surface. Then, as the percentage of water in the fish is great, the consumption of solvents is also great. The thermo-chemical method gives the best results, the materials being treated with steam under pressure which separates the fat and the dry residue can then easily be treated. The toxins in the fish are destroyed by the steam, and the meal obtained can be used as a feeding stuff for animals. After having made a study of this new problem, a firm of Zurich (Messrs. Escher, Wyss & Co.) have solved it by aid of a very simple and inexpensive plant which gives all the advantages of the thermo-chemical method for treating large quantities of fish, 4 to 6 metric tons, in 10 to 12 hours. This installation comprises: (1) A horizontal autoclave (extractor) with a double heating jacket and perforated rotary drum inside. The mouth of the autoclave is at one end. The drum is worked by pulleys and an endless screw; (2) a vertical vessel, to which the autoclave is connected, communicating by pipes with (3) a continuous press above the autoclave and resting on a gallery; (4) a fat pan fed by the press; (5) an air pump for the autoclave; (6) a steam boiler; (7) an electric motor driving the autoclave drum, pump and press. Working is as follows:—

The fish waste is put into the perforated drum, the autoclave being then shut hermetically. Hot steam is then admitted, the drum rotating continually. A mixture of oil, solid and liquid substances, run through the openings in the drum into the vertical vessel, where they separate by gravitation. When everything in the autoclave has been run off, the fat which collects on the top is drawn off, leaving the liquid and solid matter in the vessel to pass through the pipes into the press, which separates much of the water and fat from the solids.

The oily liquid runs into the pan fed by the press, and the solid parts fall through an opening into the autoclave. Then the latter is shut, and again heated, the drum, which is furnished with agilators on the

circumference, being set in moton. The air pump produces a vacuum in the autoclave, which makes dessication easy. This pump is also used to draw off the fumes which are then got rid of by condensation. The crude, dry materials are automatically discharged from the extractor, simply by making the drum rotate in the opposite direction. A little boiler supplies steam, and a 9 h.p. electric motor power. Thus this plant is very simple and highly efficient. Consumption of steam is reduced to a minimum in drying the meal, as much of the water in the fish is previously extracted and that of coal is also very small, scarcely 15 per cent. of the weight of the fish.

The meal produced is thus much freer from fat than in the ordinary thermochemical method, as the following analysis demonstrates: water, 12 to 15 per cent.: fat, 6 to 8 per cent.; residues, 13 to 28 per cent. These residues themselves contain phosphate, 5 to 7 per cent.; crude protein, 46 to 52 per cent; non-nitrogenous matter, 6 to 14 per cent. The great value of the method, however, is due to the fac that the meal can be used as a feedin stuff, and results have been so encouragin that it is not rash to assert that this metho will grow more and more important, a technical difficulties having been overcom and good plant available. The feedin value of fish meal has been illustrated experimentally with the following results:—

Meal.	Dry Matter.	Protein.	Fat.	Residues
I.	87 p.c.	48.9	2.1	25.6
II.	81 p.c.	51.5	4.8	13.5

Two groups of pigs were fed with one quality of meal, the daily rations being as follows in kilogrammes:—

Groups of pigs.	Boiled potatoes.	Waste flesh.	Potato Flakes.	Maize	Meal. I.	Meal. II.
a ..	4	0.5	0.172	0.263	0.568	
b ...	4	0.5	0.172	0.263	0.568	
c ...	4	0.5	0.172	0.263	—	0.548
d ..	4	0.5	0.127	0.263	—	0.548

Calculations made after killing the pigs demonstrate that the amount of meal (in kilogrs.) to obtain a nett increase, in weight of the pigs, of 100 kilogrammes, is:—

Groups.	Weight.	Assimilable Protein	Weight of meal equivalent to the assimilable protein.
a	399	54.12	123
b ...	386	52.32	118
c ...	388	52.46	114
d ...	366	49.54	108

The flesh of the pigs was of the finest quality and without any odour of fish. The commercial yield will, of course, depend upon quantity and quality of the raw materials. However, the following may be taken as example: 2 to 10 per cent. fat and 15 to 35 per cent. meal. The profits realised by treating 4 to 6 metric tons of fish per day, to obtain 3 per cent. fat and 20 per cent. meal, were 56,400 francs for the year, which is regarded as very satisfactory. The method described reduces the bad odours to a strict minimum, and they cause no inconveniences. — (*Revue Général du Froid, June-July*, 1922.)

DESCLOIZITE FROM SOUTH-WEST AFRICA.

By Percy A. Wagner, Ing.D., B.Sc., F.G.S., M.A.I.M.M.E.

(Communicated by permission of the Honourable the Minister for Mines and Industries.)

Superficial deposits of vanadium ore are worked at a number of localities in the Grootfontein district of the South-West Protectorate and form the basis of quite an important industry. The ores occur for the most part in sand or rubble-filled solution cavities and *karrenfelder* in the surface of the Otavi dolomite, most rarely in open solution fissures and in surface breccias, and finally as actual replacements of the dolomite, these being, however, always connected with one or another of the previously mentioned types of deposit.

Some of the occurrences have descloizite as the predominant ore mineral, others mottramite, and yet others (Berg Aukas) ap-

parently vanadinite.[1] Excellent descriptions of some of the earlier discovered occurrences have been published by H. Schneiderhohn,[2] but no comprehensive study of the deposits has as yet been made. It is evident, however, from what is known, that these are all of the nature of residual accumulations formed by the concentration, at favourable *loci*, by descending meteoric waters of small amounts of vanadium disseminated through originally overlying deposits of copper-lead-zinc ore in the Otavi dolomite or the ore-bearing aplite intrusive in that formation.[3] As the vanadium compounds are the last to survive the degradational processes, they are evidently peculiarly resistant to chemical erosion, which is all powerful in a karst region such as that under review.

The object of the present note is to describe some exceptionally handsome specimens of descloizite ore recently sent to the writer by Mr. C. G. C. Clarke, of the South-West Africa Company, Limited. They are rom two localities, namely, the farm Olifantsfontein West, situated 12 miles north-west of Grootfontein North, and the farm Abenab, situated 20 miles north of Grootfontein.

At the former, according to the description accompanying the specimens, the deposit takes the form of a well-defined vertical cleft in the dolomite, the walls of which are lined with dark lustrous crystals and crystal aggregates of descloizite forming continuous crusts, several superimposed crusts being in places present.

In the material sent to the writer, the crystals range in length from a millimetre and less to 1.7 cm. Actually the largest had a length, measured along the *c* axis, of 1.72 cm., and a breadth measured along the *b* axis of 0.8 cm. They are made up of the unit pyramid and the unit prism, the faces of the latter being generally horizontally furrowed owing to an oscillatory combination of the two forms. More rarely the pyramidal faces are terraced owing to the same cause. The habit of the crystals is sometimes prismatic, the grooving of the prism faces being then especially pronounced. More usually the pyramid and prism faces are about equally developed. Among the smaller individuals, however, crystals of pyramidal habit are fairly common. Single crystals, as a matter of fact, are rare. Even what appear at first sight to be simple forms are generally found to be made up of sub-parallel intergrowths of severe crystals, and complex spear-headed and branching groups made up of a number of such crystals sometimes symmetrically arranged about a central dominant stem crystal are very common. The crystal faces give very poor signals and do not lend themselves to accurate measurement, this applying particularly to those of the unit prism. The only angles which could be determined by means of a Fuess reflecting goniometer with even a fair degree of accuracy were as follow:—

$oo' = (111) : (1\bar{1}1) = 89° 24'$
$oo''' = (111) : (11\bar{1}) = 52° 30'$

the corresponding values given by Dana[4] being 89° 6' and 53° 4'.

The crystals are of a very dark olive green colour and their lustre is brilliant. On fractured surfaces the colour is orange brown, the fracture being uneven. The streak is pale canary-yellow. In the process of grinding down the crystals to prepare thin sections an imperfect cleavage parallel to (100) is brought out.

Under the microscope the crystals are seen to have a well-defined zonal structure, being built up of alternations of thick greenish and thinner brown or yellow layers arranged parallel with the faces. These layers are markedly pleochroic, the greenish showing:—

Z = a = pale yellowish-green,
Y = b = pale apple-green,
X = c = very pale yellowish-green,

and the brown or yellow:

Z = a = reddish-brown,
Y = b = greenish yellow,
X = c = pale yellow.

The brownish layers have a much stronger absorption than the greenish. It should be stated that the colours given refer to a fairly thick section. In addition to the brown and greenish zones, a practically colourless zone is generally present in the peripheral portion of the crystals. In one of the sections examined this showed:

ellow,
less.

[1] *According to a valuable unpublished Memorandum by Mr. G. E. B. Frood, Inspector of Mines, South-West Protectorate*

[2] *cf.* "*Die Erzlagerstätten des glandes, Deutsch-Südwestafrika,*' *und Erz.*, XVII., 13, 16, 19, 24, 10 & 11.

[3] *Schneiderhöhn, loc. cit.*, p. 33

m *of Mineralogy,*" p. 787.

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The precise significance of the zoning is not clear. It may be taken for granted, however, that the differently coloured shells also differ in chemical composition, so that instead of dealing with a *homogeneous* mineral we have to do with at least three isomorphous substances.

A chemical analysis by Dr. J. McCrae, of some selected crystals is given under I. in the following table:—

	I.	Ia.	II.	III.
PbO	55.45	0.25	55.93	54.03
ZnO	15.50	0.19	15.94	12.62
CuO	3.80	0.05	1.15	8.13
FeO	—	—	0.70	—
Fe_2O_3	0.30	—	—	—
V_2O_5	22.00	0.12	20.80	22.47
As_2O_5	Nil.	—	0.32	0.28
P_2O_5	—	—	0.27	0.17
SiO_2	Nil.	—	0.18	—
H_2O	2.50	0.14	4.37	2.70
H_2O (110°)	0.05	—	—	—
Total ...	99.60		99.82	99.74
Sp. Gr.	6.20			

Under Ia. are given the molecular proportions corresponding with the analysis. It will be seen that the figures agree fairly closely with the theoretical composition of the mineral, corresponding with the formula 2 PbO. 2(ZnCu) O. V_2O_5. 2 H_2O, according to which lead oxide and zinc *plus* copper oxide are present in equimolecular proportions, and the ratio of (Pb Zn Cu) O : V_2O_5 : : 4 : 1. The analyses under II. and III. are adduced for comparison. II. is an analysis by W. F. Hillebrand of descloizite from Beaverbrook, Montana, 0.03 per cent. of CaO and 0.06 per cent. of MgO being present in addition to the constituents named. III. is an analysis of cuprodescloizite from an unnamed locality quoted from Dana.[5] As the term cuprodescloizite appears to be reserved for varieties containing a minimum of 6 per cent. of copper oxide, the Olifantsfontein mineral, which, as we have seen, is probably a complex isomorphous mixture of at least three distinct substances, is best described as cupriferous descloizite.

The associated minerals are pellucid bluish-white quartz and calcite. The latter occurs in mammillary crusts up to 1 centimetre in thickness. In these the calcite is is eviently paramorphic after aragonite—a phenomenon also noted at other localities in the Otavi Range.[6] The original aragonite was clearly of later formation than the descloizite, having been deposited on the crystals of that mineral which project into the crusts. The quartz, on the other hand, appears to be of earlier formation than the descloizite.

Abenab.—The Abenab ore is a breccia of strikingly handsome appearance made up of angular fragments of pink surface limestone and reddish dolomite encased by crusts of dark green or brown descloizite crystals, the cementing medium being coarsely crystallised white calcite. The latter forms a network of irregular veins up to 2 centimetres, across which are interspersed with vughs lined with crystals of descloizite and colourless calcite. At least four varieties of descloizite are present, namely:—

(1) A blackish green variety occurring in well-formed pyramidal crystals somewhat elongated in the direction of the macrodiagonal. The prism faces are only very poorly developed, and the habit of the crystals is not unlike that of the descloizite from Lake Valley, New Mexico, shown in Fig. 3, p. 788, of Dana's *Mineralogy*. With the aid of a contact goniometer the following forms were found to be present:—

$o = 111$
$m = 110$
$v = 021$
$(d)? = 012$

On some crystals the faces of the unit prism are bevelled by those of another prism, probably $l = (130)$. On others the edge (111) : (111) is terraced owing to an oscillatory combination of the two clinodomal faces.

(2) A bottle-green variety occurring in smaller crystals of practically the same habit, the prism being, however, even more poorly developed. One peculiar feature of these crystals is that the clinodomal faces often have a peculiar *greenish-yellow coating*. Whether or not this is due to the alteration of the descloizite is not clear.

(3) A dull greenish-brown variety in which the babit of the crystals is tabular owing apparently to tbe abnormal development of the macropinacoid, the other forms present being the unit pyramid and the unit prism.

(4) A lustrous chrome-brown variety. occurring mostly in peculiar parallel-growth aggregates, up to 1.5 centimetres in length, imbedded in white calcite. The aggregates are due to the regular conjunction of small crystals of pyramidal

[5] "*A System of Mineralogy*," p. 789.
[6] *cf. Schneiderhöhn, loc. cit.*, p. 41.

habit and are terminated by the unit pyramid. Some of them are doubly terminated.

Chemically the several varieties enumerated appear to differ mainly as regards their copper content. The bright chrome-brown variety is practically free from that element, whereas the very dark variety contains fair quantities of it. No analysis of any particular variety is available, but a sample of the concentrate obtained by jigging the crushed ore, in which all of them are probably represented, showed:—

$PbO = 51.81$ per cent.
$ZnO = 18.06$,,
$CuO = 1.10$,,
$V_2O_5 = 20.60$,,
$P_2O_5 = 0.08$,,

The writer's thanks are due to Dr. F. E Wright and Professor Charles Palache for assistance in his investigations.

(From "The South African Journal of Science," Vol. XIX., 142-145.)

ROYAL INSTITUTION OF GREAT BRITAIN.

WEEKLY EVENING MEETING, FRIDAY, MAY 4, 1923.

SIR JAMES CRICHTON-BROWNE, M.D., LL.D., F.R.S., TREASURER AND VICE-PRESIDENT, IN THE CHAIR.

THE ORIGINS OF THE CONCEPTION OF ISOTOPES.

A Lecture delivered by Frederick Soddy, M.A., F.R.S.

(Continued from Page 95.)

Similarly, the chemical identity of radium D and lead was established as a consequence of very prolonged and refined chemical examination. Paneth and Hevesy established upon this their well-known method of using radioactive isotopes as indicators for elements in too small quantity to be dealt with except by such methods. On the principle that wherever the radioactive element is there will its inactive isotope be also, provided that they have once been properly mixed, many difficult or uncertain chemical analyses may be converted into simple radioactive ones.

In 1909 Strömholm and Svedberg made what was probably the first attempt to fit a part of the disintegration series into the Periodic Table, and although the effort in itself was in an important respect erroneous, in their paper is to be found the first anticipation that the chemical non-separability found for certain pairs and groups of radio-elements may also apply to the non-radioactive elements. Remarking on the fact that there are three parallel and independent radioactive series, they suppose this to proceed down through the Periodic Table, " but that always the three elements of the different genetic series, which thus together occupy one place in the periodic system, are so alike that they always occur together, and also have not been able to be appreciably separated in the laboratory." They point out also this idea would explain the exceptions to the periodic system " if the elements of the scheme were mixtures of several homogeneous elements of similar but not completely identical atomic weight."

In the next year I arrived independently, and without in the least postulating any continuance of the genetic series beyond the radio-elements, at a similar view. Marckwald and I found independently that mesothorium I was chemically similar to radium, a fact undoubtedly known to Hahn and those engaged in the technical extraction of mesothorium, but kept secret. It was *known from some work of Boltwood that* precipitating barium sulphate in a solution containing mesothorium removes it, but it was thought that the action of the barium sulphate was similar to that in removing uranium X, for which it had long been used —namely, a simple adsorption. I was surprised to find it absolutely different. The removal of the barium from the mesothorium, as from radium, could only be accomplished by the fractional crystallisation of the chlorides. In this fractionation the radium and mesothorium remained together and behaved as a single element. Within the limit of error of the most careful radioactive measurements, there was no change in the relative proportion of the two elements at the end of the process, from that in which they exist in the original mineral. Chemistry has many cases of elements similar in chemical character, but nothing approaching this. For we know, beforehand, that we are dealing with a mixture of two substances, and can estimate accurately the proportion of each individual. Yet to all chemical operations they behave as a

single substance. The differences of atomic weight are considerable, two units in the cases of mesothorium and radium, and of ionium and thorium, and four units in that of radiothorium and thorium. It was certain that if isotopes existed in the case of the ordinary chemical elements, the absence of a second radioactive nature independent of the chemical nature would make it impossible for them to have been recognised. Hence the implication followed that any supposed element may be a mixture of several chemical identities of different atomic weight, and any atomic weight might be merely a mean number (Ann. Reports, Chem. Soc., 1910, 286). There is an element of tragedy in this. The life-time labours of the chemists who, since the time of Stas, have devoted themselves to the exact determination of atomic weight, appear to have as little theoretical interest now, as if you sought to determine the average weight of a collection of beer bottles, all exactly alike, but not all quite full.

The Radio-Elements and the Periodic Law.

The years from 1911-1913 were crowded vith important advances, and to do the xact history justice would take an undue hare of the available time. In 1911 the hemistry of most of the α-ray giving memers were sufficiently known for it to be een that the expulsion of the α-particle aused the element expelling it to move rom the place it occupied in the Periodic able to the next place but one to it in the irection of diminishing mass.

At this time the chemistry of the postmanation members had scarcely been udied, though von Lerch, from electroemical researches, had put forward the le that the successive products are each ectrochemically "nobler" than the last, a le which describes well enough the elecochemical behaviour of the first three—e A to C members, as they are called. ien as a result of the experiments of hrader and Russell, it was found that eir volatility was much affected by emical treatment and by the atmosphere which they were volatilised. Thus, in drogen, radium C volatilises at as low a mperature as 360° C., though, in air, a mperature of 1200° C. is necessary. This early indicated the possibility that even ese excessively ephemeral elements have definite chemical character. Hevesy owed by electrochemical methods that the three B-members are identical in properties among themselves, and also the three C-members.

But the work, which, more than anything else, served to reveal as in a flash the simple and sweeping generalisation which covers the evolution of the radioactive elements was that of A. Fleck in my laboratory in Glasgow. He studied the chemistry of the various members, still uncharacterised, from the definite point of view of ascertaining to which element each most closely approximated in chemical character, and then whether it was separable from that element or not. In addition to confirming more rigorously many conclusions already reached, he proved that mesothorium 2 was non-separable from actinium, the three B-members from lead, like radium D, and the three C-members and radium E from bismuth.

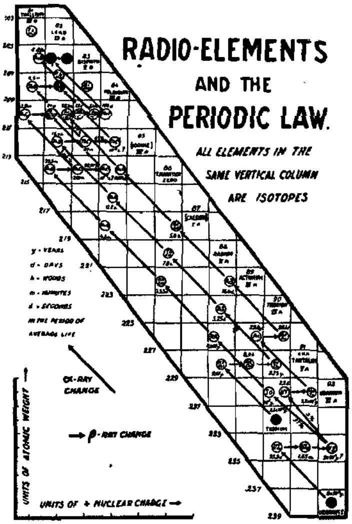
Hevesy and Russell—the first with regard to the valency of the radio-elements and the second with regard to the positions they occupy in the Periodic Table—published early in 1913 statements of the full law underlying radioactive evolution, but only in part correct. Within a month, K. Fajans in Carlsruhe published the scheme correct and complete, including the complicated branchings that occur at the C-members. In a paper, amplifying and amending Russell's scheme, I arrived independently at the same place as Fajans Each α-ray expelled causes a shift of two places in the Periodic Table in the direction of diminishing mass, and each β-ray a shift of one place in the opposite direction. In its present form the scheme is shown in the figure. The chief uncertainty remaining is whether the actinium branch starts from uranium II, as shown in the figure for convenience, or from uranium I, or even from a third independent isotope of uranium. So that the atomic weights shown for the actinium series are purely provisional.

By the consistent application of the two rules mentioned the members found to be non-separable from one another fall in the same place in the Periodic Table. The chemical character has nothing to do with the radioactivity, nor with the series to which the element belongs, nor with its atomic weight. It depends upon a number, now called the atomic number, shown at the top of the place in the figure.

Before passing on to this, the chief practical consequences of the generalisation

may be briefly enumerated.

(1) Of the members still uncharacterised, the A and C′ members must be the isotopes of polonium (radium F), and radium C_2 (now called C″), actinium D and thorium D must be isotopes of thallium. Fleck at once verified these predictions as regards radium A, actinium D and thorium D.



(2) Uranium X, like mesothorium, must consist of two successive β-ray giving products, intermediate between the two uraniums. Fajans and Gohring at once succeeded in separating from "uranium X" a very short-lived product, uranium X_2, giving the more penetrating of the two types of β-ray expelled, the uranium X_1 giving the less penetrating β-rays.

(3 The parent of actinium in the IIIrd family must be an isotope of radium, if actinium is formed in a β-ray change—a conclusion I at once experimentally disproved—or it must be an isotope of uranium X, in the Vth family, if actinium is formed in an α-ray change. This was proved by Cranston and myself, and the name "eka-tantalum" given to the new element, and by Hahn and Meitner, who named it protoactinium. It is linked to uranium through uranium Y, a branch member discovered by Antonoff in 1911, and suspected to be in the actinium series.

Protoactinium, to give it Hahn and Meitner's name, has been shown by them to give α-rays, and to be chemically so like tantalum that hitherto it has not been separated from it. Its period is about 17,000 years, and from this it may be calculated that there is about one-fifth as much of it by weight in minerals as there is of radium. This may be sufficient to enable it to be isolated and for its spectrum, atomic weight and chemical character to be ascertained. The branch series runs:—

$$\underset{\text{VI}}{\text{U}} \xrightarrow{\alpha} \underset{\text{IV}}{\text{UY}} \xrightarrow{\beta} \underset{\text{V}}{\text{Pa}} \xrightarrow{\alpha} \underset{\text{III}}{\text{Ac}} \longrightarrow \underset{\text{IV}}{\text{RaAc}} \xrightarrow{\alpha}$$

$$\underset{\text{II}}{\text{AcX}} \xrightarrow{\alpha} \underset{\text{O}}{\text{An}} \xrightarrow{\alpha} \text{\&c.}$$

in which the figures in the second line refer to the family in the Periodic Table to which the element belongs.

(4) All the ultimate products in all branches are isotopes of lead. The atomic weight of the two products of thorium are both 208, and of the major branch of uranium 206. As is well known this had only to be tested to be proved correct. The atomic weight of the lead from the purest thorium minerals is as high as 207.9, and of that from the purest uranium minerals 206. The spectra of these isotopes, but for the possible infinitesimal difference already alluded to, are identical. But the densities are proportional to their atomic weights. This was a very simple prediction I made, before testing it, from the theoretical views about to be dealt with.

The Theoretical Interpretation of Isotopes.

The results on the theoretical side were *no less definite and important, and isotopes* found a ready explanation on the nuclear theory of atomic structure put forward in a *tentative form* by Rutherford in 1911. This theory accounted for the large angles through which occasional α-particles were deflected in their passage through atoms, by the existence of a very minute highly charged nucleus at the centre of the atom, the rest of the atom being occupied by separate charges of opposite sign equal in number to the nuclear charge. For such an atom scattering should be proportional to the square of the nuclear charge. Experi-

ment showed that scattering was approximately proportional to the square of the atomic weight. So that it looked as if, as in the α-particle itself, there existed one *unit of nuclear charge to each two units of atomic weight*. This would make the nuclear charge of uranium, of atomic weight about 240, 120 +.

Since the α-particle carries two positive charges and the β-particle one negative, the obvious inference from the figure is that the successive places in the Periodic Table *correspond with unit difference in the intra-atomic charge*. This view, and also that each unit of charge corresponded to two *units of mass, had been suggested independently* by van der Broek in 1911. At first he tried to stretch the Periodic Table to make it accommodate 120 places. But, in 1913, he pointed out that the experimental *results for scattering were completely in accord* with his own view (that the number of the place is the same as the intra-atomic charge), *on the existing Periodic Table*, which accommodates only some 90 elements. It would not be inconsistent with his other view (that the nuclei of the heavy elements are made up of helium nuclei) *if there were electrons in the nucleus* as well as in the outside shell. Thus uranium in the 90th place would have to have, in addition to the 60 helium nuclei in its nucleus to account for its weight, 30 electrons, to account for its charge of 90+.

The existence of electrons as well as positive charges in the atomic nucleus was *also postulated by Bohr to explain* the emission of β-rays, for on his theory the electrons in the external shell form a stable configuration and could only be dislodged by the expenditure of work.

The Periodic Law generalisation practically settled this question. β-ray changes are no less transmutational than α-ray changes, and are sharply to be distinguished from the numerous processes, such as friction, chemical change, action of ultra-violet light and incandescence, during which electrons are detached from atoms. The effect on the chemical character produced by the expulsion of one α-particle is exactly undone by the expulsion of two β-particles, and the product becomes *isotopic with the original* parent. This means that both α- and β-*particles must be expelled from the nucleus*, and *that isotopes are elements the atoms of* which have the same *neit* nuclear charge—*i.e.*, the same excess number of positive over negative charges in the nucleus, but different numbers of positives and negatives [illegible] separately. For such systems the electronic shell would be identical, and so *the identity* of the chemical and spectroscopic character is explained. Also the atomic volume is the same — that is, the density must be proportional to the atomic weight.

We were able to get an interesting confirmation of this view. In the change of uranium X_1 to uranium II two electrons are lost as β-rays. *In the oxidation of* a uranous salt to a uranic or uranyl salt two electrons are also lost.

$$U+++ = U++ +++ + 2 E.$$

If these come from the same region of the *atom as the β-particles, then uranous salts*, so long as their valency does not change, should be like *uranium X_1, chemically* non-separable from thorium. Fleck, trying this, found great similarity in chemical properties between uranous salts and thorium, but not identity. He was able to separate them by chemical methods without changing the valency of the uranous salt.

The great merit of the nuclear atom from the chemist's point of view was that it afforded for the first time a clear picture of the difference between a chemical and a *transmutational* (*or radioactive*) change. The latter occur in the nucleus and are irreversible. The external shell accommodates itself instantly to the change of the nucleus. But any change suffered by the external shell (chemical change) has no effect on the nucleus, which always acts so as to make the external shell conform to one *most stable configuration*.

The atom is an *imperium in imperio*, and like most such systems is very conservative and resistant to change. The electrons in the shell, that govern almost all the atomic properties, except mass and radioactivity, are in turn but the bureaucratic instruments of the real government, which is the intensely charged central nucleus. The transmutation of atoms, as of social systems, is alike impossible because the apparent government is not the real government. Rutherford's experiments, on the bombardment of atoms by α-particles, show that only about one out of a hundred thousand of the latter in passing through hydrogen ever *hit a hydrogen nucleus*, and the proportion of hits to misses is something like one in one *thousand millions*. In politics, contrasting *the number of missiles hurled with the results* achieved, the shooting seems even worse. It is only when the atomic or social systems break up or break down that we learn even of the existence of their real internal constitution.

F.S.

GENERAL NOTES

THE BRITISH INDUSTRIES FAIR, 1924.

CONSIDERATIONS GOVERNING THE CHANGE OF DATE.

After considering all sides of the question and canvassing interested trade opinion, the Department of Overseas Trade and the Birmingham Committee, the respective organising authorities for the London and Birmingham sections of the British Industries Fair, have decided that next year's Fair, instead of taking place at the end of February, as would normally be the case, shall be postponed for two months.

This means that the British Industries *Fair will open in London on April* 28, continuing until May 9, while the Birmingham section will open on the Monday following the close of the Fair in London.

VISITORS FROM THE DOMINIONS.

In selecting these dates the organising authorities appreciated that the holding of the big British Empire Exhibition from April to October of 1924 must materially affect the attendance of overseas buyers. It is certain that few buyers from the Dominions will make two visits to the United Kingdom in the course of a single year, as would be necessary if the Fair were to be held two months before the opening of the Empire Exhibition. On the other hand, it is probable that many of these visitors will make a point of arriving in this country in time for the opening at Wembley, a probability which becomes almost a certainty if they can, in the course of the trip, inspect both the Exhibiton and the British Industries Fair.

The later date is also likely to benefit the Fair owing to the probable large increase in the number of Dominions business men who will make every possible effort to come to the United Kingdom next year. Nor need it be considered that this increase of visitors will be limited to the Dominions and Colonies; so large an exhibition as that of the British Empire promises to be, is a magnet to both the business man and the holiday-maker. With the Fair running concurrently with the Exhibition, many Continental buyers will assuredly seize the opportunity of combining business with pleasure by visiting this country in May next.

EXHIBITION AND FAIR COMPLEMENTARY.

While the British Industries Fair and the British Empire Exhibiton have a common object in the promotion of Empire trade, their activities are complementary rather than competitive. Participation in the Fair will, as always, be confined to British manufacturers, and admission will be restricted to trade buyers. The exhibition, on the other hand, is for the public, and welcomes participation by any British firm, whether manufacturers, merchants or retailers.

Mutual benefit to both the Exhibition and the Fair will also be possible from a combined publicity campaign.

TRADES TO BE EXHIBITED.

The schedules of trades for the London and Birmingham sections of the Fair will be similar to those of last year, London covering mainly the lighter lines of goods such as pottery, jewellery, leather and fancy goods, sports goods, musical instruments, stationery and chemicals, while exhibits at Birmingham will consist of hardware, engineering, metals, power, building, mining and agricultural implements.

Application forms for space will be issued to eligible United Kingdom firms at the beginning of October.

Since this general statement was written many replies have been received by the Department of Overseas Trade to their circular regarding the change of date. It is satisfactory to record that the vast majority of these express not only the intention of the various firms to exhibit, but also universal approval to the decision to alter the dates in the special circumstances ruling next year.

NEW POWER SCHEME FOR JOHANNESBURG.

H.M. Senior Trade Commissioner in South Africa reports that the Johannesburg Town Council has now voted in favour of the proposed new power station and advises its erection on the vacant site between the present power station and Jeppe Street. It also recommended that, in the period which must elapse before the new power station is completed, a 10,000 kilowatt generator, adaptable to the new conditions, should be installed in the old power station on temporary foundations, to be afterwards removed to its permanent position in the new station, and that the matter should be treated as urgent in order to have the set running before *the winter of 1925.*

The total cost of the new station will be

about £500,000; it will be equipped with two 10,000 k.w. generators, together with two generators from the old station, so as to give a capacity of 39,000 k.w.

The Finance Committee has also recommended the erection of this power station, provided that authority is obtained from the Administrator to borrow an amount of £525,000.

Copies of press cuttings in connection with this matter may be inspected by United Kingdom firms interested on application to the Department of Overseas Trade (Room 52), 35, Old Queen Street, London, S.W.1. (Reference No. 11670/E.D./E.P.)

IN PARLIAMENT.

In the House of Commons, Mr. Shinwell asked the President of the Board of Trade whether he was aware that sulphate of ammonia for export from the Clyde was not being weighed and checked, and that sealed samples were no longer taken; and whether, since this was contrary to custom, he proposed to take action in the matter.

Viscount Wolmer, Under-Secretary to the Board of Trade, said: The official control of the export of sulphate of ammonia, which was instituted during the war, is now at an end. The export is, accordingly, subject only to the ordinary Customs regulations, and I have no reason to think that these regulations are not being observed. The hon. member appears to be referring to certain trade arrangements, over which the Board of Trade have no control.

Mr. Herbert Spencer asked the President of the Board of Trade whether his attention had been called to the statement of the President of the Colour Users' Association to the Manchester Chamber of Commerce of 23rd February, 1923, in which he asked the Government to redeem its pledge that the Act should not jeopardise the using industries; and whether the Government did propose to do so; further, whether his attention had been called to the statement of the President of the Colour Users' Association that prices both of home-produced and reparation dyestuffs were at an artificially high level, 300 to 400 per cent. above pre-war; and what steps he proposed to take to remedy this.

Sir Philip Lloyd-Greame replied: I am in constant communication with the representatives of the dye-making and dye-using industries, and every effort is being made to secure that the Dyestuffs (Import Regulation) Act is administered in such a manner as to promote the best interests of both parties.

In a lecture recently given by Evan James McGillivray, at the Institute of Chemistry, some interesting points are raised as to the right to use the title "Chemist."

Mr. McGillivray made some extracts from Dr. Spratt's "History of the Royal Society," written in the 17th century, where it is suggested that the chemist "must be rather innocent and virtuous than knowing" —qualifications that are well worth bearing in mind.

According to Dr. Spratt, chemists of his day might be divided into three ranks—

"Such as look after the knowledge of Nature in general."

"Such as seek out and prepare medicines."

"Such as seek after riches by transmutations and the great Elixir."

The lecturer suggested that those who composed the Chemical Society at the time of its foundation were the successors of the men to whom Dr. Spratt refers as those "who look after the knowledge of Nature in general," and that they were very little known to the general public.

Of the other two ranks, the pharmaceutical chemist is still known to the public as a chemist, while those who sought after riches by transmutations and the great Elixir have disappeared—killed by ridicule and failure.

We have received a copy of the Index to Vol. I. of the Bureau of Bio-Technology and are asked to make it known that it may be obtained on application to Messrs. Murphy & Son, Ltd., Cedars Laboratories, Sheen Lane, Mortlake, London, S.W.14.

DEPARTMENT OF OVERSEAS TRADE

Report on His Majesty's Trade Commissioner at Toronto in regard to an Official Tour of Western Ontario; June, 1923.

An official tour was made by His Majesty's Trade Commissioner at Toronto (Mr. F. W. Field) to cities and towns in Western Ontario during the early part

May and the latter end of June. Among the places visited were Hamilton, St. Catherines, Niagara Falls, Thorold, Brantford, London, Chatham, Stratford, Windsor, Walkerville, Ford, Amberstburg, and Ojibway.

A large number of calls were made upon manufacturers, who are importers of various commidities, merchants, and others likely to be interested in sources of supply in the United Kingdom.

These official tours, which are a part of the duties of all of His Majesty's Trade Commissioners, are believed to be of considerable value in relation to the expansion of British trade. In the case under review, contact was established or maintained with Chambers of Commerce, Industrial Commissioners, Purchasing Agents, and others interested. The Trade Commissioner reports that business men in Ontario generally appreciate the work of the Department of Overseas Trade in assisting to develop British trade here in face of keen foreign competition. He adds that he is always given a friendly reception and every possible assistance. Considerable publicity in the interests of British trade was also secured through press interviews at the various points visited.

Enquiries were received by the Trade Commissioner during his tour for prices of United Kingdom manufacturers of yarns, dyeing machinery, alloy steels, wire drawing machinery, paper tubes, vegetable parchment paper, fluospar, duck filter cloth, soda ash, etc. These were brought to the notice of United Kingdom firms. A recent enquiry of this character has led to an important new connection or United Kingdom chemical manufacturers.

SILK DYEING.

A visit was made to the silk dyeing works which were recently established in St. Catherines, Ontario, where it was learned that a considerable volume of silk goods in the grey are being imported from foreign countries and dyed locally. A special report on this matter is available to firms interested upon application to the Department of Overseas Trade.

AMERICAN BRANCH WORKS.

American companies continue to erect branch works in Western Ontario. Two of the most recent additions are the United States Light and Heat Company and the Dominion Insulator and Manufacturing Co. The latter firm are one of two insulator manufacturers in Ontario which specialise in high voltage work. Clay is imported from the parent company prepared ready for use in the Canadian works.

The establishment in Canada of so many branch works of United States firms naturally tends to divert trade to the United States. Many of the Canadian branches purchase a substantial portion of their requirements through their head office in the United States which in some cases entirely controls the purchasing policy of the Canadian branch. Production costs in Ontario are frequently reported as being higher than in the parent works in the United States.

AMERICAN CAPITAL IN CANADA.

It was recently estimated by a reliable authority that more than two hundred branch factories were opened in Canada by Americans in 1919, and a great number in 1920 and 1921, and that late in 1922 there must have been over seven hundred such establishments, with a further number seeking suitable locations. One of the incentives for this development is that the American manufacturers can thus supply the Canadian market and at the same time escape the Canadian tariff. Another is that by manufacturing in Canada they are able to enjoy the preferential treatment accorded to Canadian goods by many countries within the British Empire, while, under the terms of an agreement with France existing since 1907, Canada's products enter that country under especially favourable conditions.

BRITISH BRANCH WORKS.

A number of United Kingdom manufacturers are believed to be considering the matter of branch works in Canada, particularly in Ontario and Quebec Provinces. These include makers of artificial silk yarn and engineering lines. An English firm of tobacco merchants recently established processing works in Ontario.

CHEMICAL INDUSTRIES.

The Norton Company proposes to enlarge its electric furnace plant at Chippewa, near Niagara Falls, by adding a furnace building to be used exclusively for the manufacture of a carbide of silicon abrasive known as Crystolon. The development will cost about $165,000, and ensure a 25 per cent. increase in production of this line.

There are two cities bearing the name of Niagara Falls. One is in Ontario and one in New York State. They face each other, the river dividing them. Both are the sites of important industries. The Falls themselves are just as much a Canadian institution as

they are American, and the famous "Horse-shoe Falls" of Niagara are in Canada. Power is developed at Niagara Falls, Ontario, by the Hydro-Electric Power Commission of Ontario for long distance transmission to all parts of Ontario and to several parts of new York State.

The American Cynamid Company have works at Niagara Falls where the company's output is equally divided between cynamid, one of the raw materials of fertiliser, and cyanide, used in mining. The mining industry has shown marked improvement, with the result that sales of cyanide have been made to the gold mines in the South African Rand as well as in Canada, the United States and Mexico.

BUSINESS CONDITIONS.

Business conditions in Western Ontario still leave something to be desired, but they are gradually improving. The iron and steel industries have recently been more active, largely as a result of orders placed by the railway organisations and by those responsible for bridge and office building construction. Knitted goods, sports clothing, and ladies' clothing manufacturers have also been busy, but men's wear factories have been less active. The demand for machine tools is only fair, but shows improvement. Cotton mills are well occupied. Woollen mills have some idle machinery and complain of active British competition. Chemical makers are experiencing an active demand. Motor car makers are busy.

Wholesale houses report a good demand for staple lines and retail shops are doing a satisfactory seasonable trade.

Collections continue to be reported as difficult.

British manufacturers have made some headway recently in securing a share of Ontario's import trade. This is true of the woollen, hosiery, and chinaware trades particularly. British trade has also been fairly good in fancy leather goods, sporting goods and cloths, chemicals and, to a lesser extent, in metals and machinery.

The competition to be met in Ontario is very keen in the majority of lines, both from Canadian and United States manufacturers. France, Belgium, Sweden, and Japan are also active in certain trades.

MACHINERY.

Much machinery of United States manufacture is in use in Ontario factories, and orders continue to be placed there by local buyers. Many factories assist the sales of machinery competing with that of United [illegible] manufacturers. For example, the majority of Canadian machinists are accustomed to work on American machines, and some difficulty and trouble are experienced in training them to use machines to which they are not accustomed. Operators sometimes state that they prefer the light-weight machines of our competitors rather than heavier build of British machines, although there is no doubt, as a rule, as to the better finish and durability of British machines. The difficulty in having repairs made without delay and in securing the rapid delivery of spare parts are other reasons operating against larger sales of British machines. The Trade Commissioner expressed the belief that there appears to be an opportunity for increased sales of machinery of various makes in this market, including air compressors, hoisting machinery, mining equipment, textile machinery, and various other lines in which United Kingdom firms have proved specialists. Three of the factors operating against greater business are the lack of sufficient local representation and active salesmanship, the failure of United Kingdom manufacturers to keep in constant touch with those who have purchased their machines, and the inability to effect repairs and supply spare parts at short notice. While the business in any one line may not be large enough to justify the establishment of a proper local organisation, which should remove the difficulties noted, it might prove feasible for several manufacturers of non-competing machinery to have joint representation here, with a technical man to look after repairs; a good sales organisation, which would adopt the American "follow up" system, as it is termed; and a stock of the spare parts which are most likely to be needed. Unless some such system is adopted, it is to be feared that the imports of United Kingdom machinery to this market will become continually smaller.

VISITS TO CANADA.

The Trade Commissioner has again strongly recommended a personal visit of United Kingdom manufacturers to the Ontario market in order to appreciate fully the difficulties which United Kingdom manufacturers have to solve in order to secure a profitable amount of the business offering. Indeed, he states that unless the United Kingdom manufacturer is fully conversant with what is termed the "selling atmosphere" of the market, little success is likely to result from efforts to establish or extend trade in that particular market.

The Canadian manager of branch work

of a United Kingdom manufacturer of engineering equipment has suggested that Unite dKingdom firms establishing works in Canada should consult the Trade Commissioners in regard to other branch houses there, in order that equipment and supplies may be purchased as far as possible from other United Kingdom firms in Canada, rather than from foreign suppliers.

DOMINION BUREAU OF STATISTICS, CANADA.

R. H. Coats, B.A., F.S.S., F.R.C.S., Dominion Statistician; S. J. Cook, B.A., A.I.C., Chief of the Mining Metallurgical and Chemical Branch.

REVISED STATISTICS ON THE MINERAL PRODUCTION OF CANADA, 1922.

No. 1.—Cobalt.

Date of Issue, July 16, 1923.

The Dominion Bureau of Statistics issues the following finally revised statistics on the production of cobalt in Canada during 1922.

The major portion of the world's supply of cobalt for almost two decades has been derived from the silver-cobalt-nickel arsenides of the Cobalt district.

During 1922, three smelters in Ontario treating ores and residues from this district marketed cobalt oxide, metallic cobalt, cobalt sulphate, cobalt carbonate, cobalt hydroxide, unseparated oxide and stellite (an alloy of cobalt used for high speed tool metal). The cobalt residues from the cyanide process were mainly treated in Canada during 1922, although some of these, as well as smelter residues amounting in all to 518 tons, containing 173,211 lbs. of cobalt, were shipped abroad for treatment.

The cobalt production of Canada in 1922 was 569,960 lbs., which, at $3.25 per pound, would be worth $1,852,370. These figures were obtained as the total of the metal cobalt contained in smelter products made in 1922 and cobalt in residues exported for treatment, valued at $3.25, which was the average New York quotation for cobalt during the year.

Summary of Cobalt Production Statistics, 1922.

Cobalt ores and residues treated or in process, 3,719 tons.

Metallic cobalt content of the above (by assay), 536,400 lbs.

	Output of Smelters.		Marketed.	
	Total lb.	Cobalt Contained lb.	Quantity lb.	Value as reported by Smelters. $
Metallic cobalt	106,274	106,274	109,067	282,602
Cobalt oxide	360,495	252,347	398,697	798,271
Mixed oxide	86,730	39,023	123,605	99,687
Residues exported	A	172,311	1,036,000	156,402B
Total	Quantity	569,960	......	1,336,962
	Computed value	1,852,370		

A — Not given; B — Estimated.

NOTICES OF BOOKS.

The Discovery of the Nature of the Air and of its Changes during Breathing, by Clara M. Taylor, M.A. Geo. Bell & Sons, Ltd., London. 1923. Price 1s. 6d. net.

This work forms part of a series of classics of scientific method edited by E. R. Thomas, M.A., M.Sc., Headmaster of the Royal Grammar School, Newcastle-on-Tyne, and the object of the series is to provide reproductions of the great masterpieces of science in convenient form, together with an account of the action and reaction of ideas which, through the process of time, led up to the crucial experiments carried out and described by some great master, and the hope is expressed that a reader taking up a volume of the series dealing with a branch of science of which he is ignorant will be able, without further help, to trace the steps by which the human mind has passed from chaotic ignorance to ordered knowledge.

The volume in question contains eight

chapters referring to researches from those of Robert Boyle in 1627-1691 to those of Lavoisier in 1743-1794. A great many illustrations and portraits are given of the men whose works are described, and many details are recorded of the work of these early investigators that it would be difficult for the ordinary student to obtain. The book is written in a style that it is very easy to follow. At the end of each chapter there is a short summary giving the dates of the investigations and the evidence they obtained.

A great many of the memoirs referred to are quoted in full, particularly that of Lavoisier on the respiration of animals and the changes which occur in air as it passes through the lungs.

The book ends with a summary of the progress in knowledge of respiration, commencing with Harvey's discovery of the circulation of the blood in 1678 to the work of Lavoisier in 1743.

BOOKS RECEIVED.

The Paper-Makers' Directory of All Nations. Pp. XLIX. + 971. Thirty-Second Edition, 1923. Messrs. Dean & Son, Ltd., Debrett House, 29, King Street, Covent Garden, W.C.2. Price 21s.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5. Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

19218—Kenkel et Cie.—Treatment of ammonium chloride lyes in iron vessels. July 26.

19299—Michael & Co., J.—Manufacture of nitrate of potassium. July 27.

18944—Pratt, J. T.—Desulphurising iron, steel, and ferro-alloys. July 24.

Specifications Published this Week.

17528—Posseyer Abwasser-und-Wasserreini-Gungs Ges, E.—Removal of phenol and its homologues from waste waters.

178824—Metz, H. A.—Complex arseno-stibino compounds and process of making the same.

200760—Koppers Co.—Recovery of alkali thiosulphates ...

200151—Howards & Sons, Ltd., and Blagden, J. W. —Manufacture of thymol.

200160—Plauson's (Parent Co.), Ltd.—Manufacture of cellulose derivatives and fibrous products.

200167—Adam, W. G., Siderfin, N. E., Murdoch, D. G., and Galbraith, W. L.—Chemical reduction of organic compounds.

200176—Spensley, J. W., and Chemical Engineering Co. (Manchester), Ltd.—Production, mixing, blending, or refining of food products containing fats.

200186—Zdanowich, J. O.—Manufacture of cellulose acetates.

Abstract Published this Week.

198829—Pyrazolone derivative; dyes. — Soc. of Chemical Industry in Basle, Switzerland.

1-(2-Methyl-3-sulpho-5-isopropy) phenyl-3-methyl-5-pyrazolone is prepared by condensing the hydrazine from 2-aminocymene-6-sulphonic acid with ethyl acetoacetate. An example is given in which diazotized aminocymene sulphonic acid is reduced with sulphite and the hydrazine then condensed with ethyl acetoacetate.

Monoazodyes which dye wool in yellow shades similar to those of tartrazine but faster to light are obtained by coupling the above described pyrazolone derivative with diazo compounds of the benzene or naphthalene series; in an example diazo-benzene is used.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only and forward on post free for the price of 1s. 6d each.

UNIVERSITY OF MANCHESTER.

CHEMISTRY COURSES.

A PROSPECTUS containing full particulars of the Lectures and Laboratory Courses qualifying for Degrees in Chemistry will be forwarded on application to the Internal Registrar.

The *Session Commences* on October 4th

Applications for admission to the Research Laboratories should be made to the Director of the Chemical Laboratories

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THE CHEMICAL NEWS,

VOL. CXXVII. No. 3306.

ORGANIC COMPOUNDS OF ARSENIC.

PART IIIa.

By R. F. Hunter, F.C.S.

Salvarsan.

The high physiological activity of the cacodyl compounds is traced to the presence of tervalent arsenic. This led Erlick to study the tervalent arsenic compounds which are generally obtained by reducing the corresponding atoxyls.

A drug of high trypan ocidal power is "Spirarsyl," and has a constitution
CO_2 Na CH_2 N H C_6H_4 As =
As C_6H_4 N H C H_2CO_2 Na,
and is much less toxic than atoxyl.

The work that has been done on this subject (I refer to salvarsan) at first sight, appears overwhelming, and no attempt can be made to give anything like a complete survey of the work. The suggestion is, then, to follow Morgan's classification, and to consider a few of the more important compounds. The preparation of salvarsan following Kolleman can be represented:

$C_6H_5(OH)$ P $(OH)C_6H_4$ $AsO(OH)_2$
As $O(OH)_2$ C_6H_3 $(NO)_2OH$
As $O(OH)_2$ C_6H_3 $(NH_2)OH$
AsO C_6H_3 (NH_2) OH
HO (NH_2) C_6H_3 As : As C_6H_3 (NH_2) OH

1.—Reduction products of p-hydroxyphenyl arsenic acid and derivatives:

These we can enunciate briefly as
p-hydroxy phenyl arsenious oxide;
p-arsenophenol;
Tetra chlorarsenophenol;
and arsenobenzene is H oxymethylene carboxylic acid
CO_2H CH_2O O_6H_4As As C_6H_4O CH_2CO_2H, which found great use in case of animals infected with trypanosomes.

2.—Amino aryl derivatives which contain tervalent arsenic:

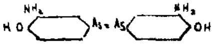
p-Amino phenyl arsenious oxide, $NH_2C_6H_4As$ $2H_2O$, is prepared by reducing atoxyl with SO_2 and HI.

Derivatives worthy of note are:

2-Aminotolyl-5-arsenious oxide 2-acetyl amino 1:5-benzarsenious conde.

3.—Salvarsan:

3: 3′ Diamine 4: 4′ dehydroxy arsenobenzene



Commercially the compound is generally used as its hydrochloride.

Commercial samples contain impurities, and in some recent investigations King isolated a number of sulphur compounds from the commercial salt (*J.C.S.*, 1921).

The solution of salvarsan in water is acid, and it is necessary to neutralise this acidity previous to injection, one of the disadvantages of salvarsan. As a derivative of arsenobenzene, salvarsan is exceedingly readily oxidised by air. This is important because the product of oxidation is 3-amine-4-hydroxyphenyl arsenious oxide, which is very much more toxic than salvarsan.

Sodium salvarsan has been much used in venereal work.

Copper salvarsan in sleeping sickness: Methylation of salvarsan decreases its healing powers.

4.—Isomerides of salvarsan:

The medicinal value of the isomerides is in all cases less than that of salvarsan. The following isomerides have been prepared:

4: 4′ diamino.
3: 3′ dehydroxy arsenobenzene
2: 2′ .... 2: 2′ ......
2: 2′ .... 5: 5′ ......
and 4: 4′ .... 2: 2′ ......

5.—Derivatives and homologues of salvarsan:

Some of these are worthy of mention.

3-Methylamino-4-hydroxy phenyl arsenic acid. Sym. 3:3′ dimethylamino 4:4′ dehydroxy arsenobenzene.

3-Dimethylamino-4-hydroxy phenylarsenic acid are examples of N. methyl derivatives, while

3 3′ diamino 2 2′ dehydroxy 5 5′ arsenotoluene 4 4′ diamino 5 5′ dehydroxy 2 2′ arsenotoluene are examples of C methyl derivatives.

5 5′ dichloro 4: 4′ diamino 3 3′ dehydroxy arsenobenzene 4 4′ diamino α-arsenonaphthalene and 3: 3′ diamino 4 4′ dehydroxy α-arsenonaphthalene have been prepared.

Stilbene analogues such as
5: 5′ diamino 2: 2′ stilhene 1: 1′ diarsenic acid 5: 5′ diamino 4: 4′ dehydroxy 1: 1′ arsenic 2: 2′ stilbene, are known.

Also the mixed aromatic-aliphatic cacodyl analogue of salvarsan, viz., 3: 3′ diamino 4: 4′ dehydroxy diphenyl dimethyl diarsine has been prepared.

6.—Tetraminoarsenobenzenes:

Among the reduction products of 2: 4 dinitro phenylarsenic acid we might mention

2: 4 Dinitro phenylarsenious oxide, and 2: 4, 2′: 4′ Tetranitro arsenobenzene.

7.—5: 5′ Diamino 2: 4 : 2′ 4′ tetra hydroxy arseno benzene and derivatives:

Among the preparations which have been carried out are those of

2: 4 Dihydroxy phenyl arsenic acid and 5: 5′ Diamino 2: 2′ dimethoxy 4: 4′ dehydroxy arsenobenzene.

8.—Hexamino arsenobenzene and derivatives:

4: 4′ Tetramethyl 3:4 : 5 : 3′ : 4′ : 5′ hexaminoarseno benzene is said to be a promising tervalent arsenic compound.

PART IIIb.

Neo Salvarsan:

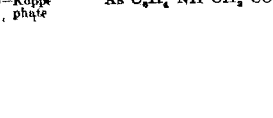
Sodium 3: 3′ Diamino 4: 4′ dehydroxy arsenobenzene. N. Methylene sulphinate

Neo salvarsan is prepared from salvarsan hydrochloride by treatment with sodium formaldehyde sulphoxylate in aqueous solution, followed by 10 per cent. $Na_2 Co_3$ when 3: 3′ diamino 4: 4′ dehydroxy arsenobenzene N. methylene sulphonic acid precipitates from which the sodium salt, neo salvarsan, can be obtained.

Neo salvarsan is neutral in solution; its curative effect is much the same as salvarsan, but greater doses must be applied.

2.—Galyl 4: 4′ dehydroxy arsenobenzene 3: 3′ phosphamic acid is an arsenical drug which is acidic and dissolves in aqueous Na_2CO_3 to a neutral solution and is very suitable for intravenous injection in treatment of syphillis.

Ludyl or benzene m 3′: 3′ disulphamino bis 3 amino 4: 4′ dehydroxy arsenobenzene is also used in syphillis, and has a structure



17...

Arsenoarylglycines, an example of

178824—Bis arseno phenyl p glycine,

pour H_2 NH C_6H_4 As:

200760—Koppe As C_6H_4 NH CH_2 CO_2 H

phate

the sodium salt of which is "spirasyl. Arsenohippuric acid has recently been pre pared and has a constitution

CO_2 H CH_2 N H C O C_6H_4 As:

As C_6H_4 CO N H C H_2 CO_2 H

In conclusion, we have surveyed in a infinitesimally small way the work whic has been done on arsenic organic com pounds.

That the ultimate cure for syphillis, th worst of the two venereal diseases, will b an arsenic aromatic or hetero cyclic, ther can be little doubt; when we consider tha in 1918 the figures given for British troop suffering from venereal disease amounted t 200.000, we get a vague conception of th magnitude of the vital problem of arseni organic derivatives. From the brilliant wor done by our scientific men in this field c research, we are sanguine enough to hop that in a few years' time we shall see th advent of a cure, better by far than eithe neo salvarsan or its derivatives, if not th absolute cure for that filthy and contagiou disease, once unknown in this country, no having spread and spreading to a ghastl degree, which we call "syphillis" by name

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NOTES ON THE QUANTITY AND PROPERTIES OF CHARCOAL OBTAINED FROM VARIOUS KINDS OF SIAMESE WOODS.

By Dr. G. Bossoni, Royal Naval Ordnanc Department, Bang Na (Siam).

March, 1923.

It is well known how great is the import ance of charcoal in the manufacture c black powder, and how the quality and pro perties of charcoal are intimately connecte with the quality and properties of blac powder.

In fact, the combustion of black powde depends in great part on the facility an rapidity of the combustion of charcoa therefore before proceeding to the manufac ture of black powder, it is necessary to stud the properties of the charcoal which enter into the composition of the powder. Fo this purpose, Section IV. of the R. Siames Naval Ordnance Dept. has undertaken som experiments on the quality and quantity c charcoal yielded by several kinds of com mon Siamese woods, and as the yield c charcoal depends not only upon the kind o wood, but also upon the manner of charrin employed, so the experiments were rigor

ously performed under the same conditions and at the same temperature (350° C.) for all the woods.

The wood was cut from trees approximately three years old during the dry season, and the branches not more than 4 centimetres thick, about 50 centimetres long, were stripped of the bark and then charred.

Table No. 1 shows the various kinds of woods in the order of their yield of charcoal, together with the specific gravity of the charcoal.

Table No. 2 shows the results obtained from the analysis of charcoal residue in the still, per cent.

As the charcoal most suitable for the manufacture of gun powder is the one which burns most quickly and gives the least quantity of ash, experiments were undertaken to determine the rate of combustion of the various kinds of charcoal, according to the Proust's method. A mixture of 0.645 grammes of saltpetre to 0.130 gramme of charcoal was placed in copper tubes 6 centimetres long and 6 millimetres in diameter, and ignited by a little meal powder. Table No. 3 shows the results obtained.

In conclusion, from the above experiments it appears that although the quantity of charcoal obtained from 100 parts of Mai Makham Teth (Pithecolobium dulce), and Mai Kaa (Sesbania grandiflora) is higher than the quantity yielded by the other woods, the charcoals obtained from Mai Thonglang (Erytrina indica) and Mai Tinpet (Alstonia scholaris) is richer in carbonium and burns more quickly.

I wish to take this opportunity of expressing my thanks to Dr. F. G. Kerr, of the Botanical Section, Dept. of Commerce, and Mr. W. F. Lloyd, Conservator of Forests, for informations with regard to the botanical names of trees.

TABLE No. 1.

	Drying.				Charring.			
	Weight of the wood.		Loss.		Weight of the wood dried previously at 100° C.			
	Before drying.	After drying.	Off weight of dry wood	Per cent.	Before charring.	After charring.	Quantity of charcoal obtained from 100 parts of wood.	Specific Gravity of charcoal.
Mai Makham Teth (Pithecolobium dulce)	25.00	15.97	9.03	36.12	15.97	6.06	37.94	1.74
Mai Kaa (Sesbania grandiflora)	22.00	19.27	2.73	12.40	19.27	7.09	36.79	1.318
Mai Pho Tale (Hibiscus Tiliaceus)	18.00	16.14	1.86	10.33	16.14	5.43	33.64	1.31
Mai Tinpet (Alstonia scholaris)	22.50	12.35	8.15	39.75	12.35	3.49	28.25	1.47
Mai Thonglang (Erytrina Indica)	25.00	22.80	2.20	8.80	22.80	5.29	23.20	1.75
Mai Lampoo (Sonneratia acida) ...	20.00	9.24	10.76	53.80	9.24	2.18	23.59	1.57

TABLE No. 2.

Analysis of Charcoal obtained from	Carbon.	Oxygen.	Hydrogen.	Nitrogen.	Ashes.
Pithecolobium dulce	78.10	16.50	3.67	Traces	1.60
Sesbania grandiflora.	77.90	16.40	3.75	do.	1.85
Hibiscus tiliaceus	77.02	17.00	3.70	do.	2.25
Alstonia scholaris	80.13	14.90	3.68	do.	1.15
Erytrina indica	81.28	14.02	3.50	do.	1.10
Sonneratia acida	76.85	16.80	3.90	do.	2.40

TABLE No. 3.

Mixture of 0.645 gm. of KNO_3 and 0.130 gm. of charcoal made from:	Duration of Combustion.	Weight of residue in gramme.
Pithecolobium dulce ...	16 secs.	0.388
Sesbania grandiflora	15 do.	0.378
Hibiscus tiliaceus	18 do.	0.395
Alstonia scholaris	12 do.	0.362
Erytrina indica	11 do.	0.375
Sonneratia acida	20 do.	0.450

BOARD OF EDUCATION.

ARRANGEMENTS AND CONDITIONS FOR THE AWARD OF NATIONAL CERTIFICATES IN CHEMISTRY TO STUDENTS IN TECHNICAL SCHOOLS AND COLLEGES IN ENGLAND AND WALES.

NOTE.—The Institute of Chemistry is undertaking the functions assigned to it in these Rules at the invitation of the Board of Education. In these Rules the Institute of Chemistry is referred to as the "Institute," and the Board of Education as the "Board."

1.—The Institute in conjunction with the Board is prepared to approve schemes, submitted by technical schools or colleges, for the award of certificates relating to part-time and full-time grouped courses in chemistry conducted under approved conditions. To avoid possible misunderstanding, the certificates will bear a statement indicating that they are distinct from the Associateship and Fellowship Diplomas awarded by the Institute.

PART-TIME COURSES.

2.—Courses for the purpose of a part-[ti]me course certificate under these Rules [should] be carried on for at least 180 hours in [each year]. If the instruction is given exclusively in evening classes, the course should, as a rule, be carried on for three evenings a week during the school session. These courses are classified as follows:—

(i) *Senior*, adapted to the needs of students who have completed satisfactorily a *junior part-time*, course of two years' duration; or have had full-time continuous education up to the age of 15 or 16. Senior courses must extend over at least three years; and should include, in addition to Chemistry, suitable Physics and Mathematics as cognate subjects. Certificates relating to senior courses will be termed "Part-time Course Certificates in Chemistry (Ordinary)."

(ii) *Advanced*, adapted to the needs of students who have completed satisfactorily a senior part-time course or are otherwise suitably qualified (see paragraph 5), and aim at reaching, within the limits of the subjects covered by them, the standard of university work. Advanced courses must extend over at least two years; and should include, in addition to Chemistry, suitable cognate subjects. They may include the study of the application to chemical practice of scientific principles with which the students have become familiar.* Certificates relating to advanced courses will be termed "Part-time Course Certificates in Chemistry (Higher)."

As a rule, the whole of a part-time course must be taken by the student at one school, but subject to previous approval by the Institute and the Board different years

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* *With the approval of the Institute and the Board this study may, in certain subjects, be commenced in the third year of a senior course.*

of the course may be assigned to different schools with suitably co-ordinated curricula; and the courses of instruction previously taken by a student who has migrated from one area to another, or by a student who has received satisfactory instruction in science at a secondary school or elsewhere, may be accepted in lieu of such portion of a part-time course, other than the final year, as may be approved previously by the Institute and the Board in each case.

The Part-time Course Certificates (Ordinary and Higher) will record the subjects constituting the course.

FULL-TIME COURSES.

3.—Courses for the purpose of a full-time course certificate under these Rules are classified as follows:—

(i) *Full-time Course in Chemistry*, suitable for students who have attended a secondary school up to the age of 16. Full-time courses in Chemistry must extend over at least three years, and should include, in addition to Chemistry, suitable Physics, Mathematics, and one or more modern languages, and may include other cognate subjects. Certificates relating to full-time courses in Chemistry will be termed "Full-time Course Certificates in Chemistry."

(ii) *Full-time Course in Applied Chemistry*, restricted to students who have completed satisfactorily a full-time course in Chemistry, or an advanced part-time course in Chemistry, or other course approved by the Institute and the Board. Full-time courses in Applied Chemistry must extend over at least one year; and should include, in addition to Chemistry, suitable cognate subjects, one of which involves the study of the application to chemical practice of scientific principles with which the students have become familiar. Certificates relating to full-time courses in Applied Chemistry will be termed "Full-time Course Certificates in Applied Chemistry."

As a rule, the whole of a full-time course must be taken by the student at one school, but the Institute and the Board may approve, exceptionally, arrangements for assigning portions of the course to different schools.

The Full-time Course Certificates in Chemistry and in Applied Chemistry will record the subjects constituting the course.

APPROVAL OF SCHEMES.

Institute and the Board must be submitted in accordance with the instructions of paragraph 13. Before approving a scheme, the Institute and the Board will require to be satisfied, for the purposes of the courses under these Rules, as to the equipment of the school, the qualifications of the staff, and the curriculum and syllabuses of instruction in the several subjects.

The approval of a school in respect of equipment, staffing, etc., for the purposes of the courses under these Rules will not necessarily imply that the school may be recognised under the Institute's Regulations as suitable for the training of candidates for the examinations for the Associateship and Fellowship of the Institute; nor will recognition of a school for grant under the Board's Regulations for Technical Schools, etc., necessarily imply that the conditions in regard to equipment, staffing, etc., are such as the Institute and the Board can accept for the purposes of the award of national certificates.

5.—Steps must be taken to secure that students are not admitted to the courses unless they are qualified to profit by them. For the present, evidence of having passed an approved preliminary examination prior to admission to a senior part-time course will not be required. For students in an advanced part-time course who have not completed a senior part-time course, evidence satisfactory to the Institute and the Board as to the attainment of the standard of the Part-time Course Certificate (Ordinary) must be produced. Normally, evidence of having passed an approved preliminary examination prior to admission to a full-time course will be required, except for students who have completed an advanced part-time course.

6.—The conditions of a scheme with respect to home work, laboratory work and records, and examinations (see paragraph 7) prior to the final year of the course, must be submitted for the approval of the Institute and the Board.

7.—Examinations, including practical tests in appropriate subjects, upon the courses of study detailed in the syllabuses constituting part of the approved scheme must be held in each year of the course. These examinations must be held by the teachers, or by an examining body duly approved for the purpose by the Institute the Board; and for the examination scale final year of the course the exami

When a common examination is held in connection with the award both of national certificates and of school or college certificates or diplomas, it will be a condition of approval of a scheme that no candidate shall be awarded a school or college certificate or diploma on the result of such examination in any year in which he has failed to obtain a national certificate.

EXAMINATIONS.

8.—A memorandum prepared by the Institute and the Board as to the conduct and supervision of the final examinations under these Rules can be obtained from the Board, and arrangements in conformity therewith must be made by the school or college authorities. The examinations will be open to inspection by His Majesty's Inspectors.

The final practical examinations should be conducted, so far as possible, under such conditions as to time allowance and library facilities as would obtain in ordinary chemical practice.

9.—To satisfy the Institute and the Board in respect both of the standard of the questions set and of the marking of the examination scripts, the Institute will appoint assessors who will act under the joint control of the Institute and the Board.

The assessors will revise the examination papers set at the end of the final year of the course, and will have the option of substituting questions up to 40 per cent. of the total number of questions set. They may make any questions compulsory, provided that the number so made compulsory shall not exceed about 40 per cent. of the number to be answered.

The marking by the examiners of the scripts worked in the final examination will be subject to revision by the assessors, and the marks as accepted or revised by them will be taken into account as explained below for the purpose of awarding certificates, and, in respect o advanced part-time courses and of full-time courses, for the purpose of awarding distinctions in accordance with the conditions of paragraph 11. The assessors may also satisfy themselves with regard to the amount and standard of the laboratory work done by each student throughout the course, as recorded in the laboratory notebooks (see paragraph 19).

17882 [CON]DITIONS OF AWARD OF CERTIFICATES.

[1]To qualify for the award of a certi- the possible attendances in each year of the course;

(ii) fulfilled the conditions of the approved scheme with respect to examinations, home work, and laboratory work and records in each year of the course prior to the final year;*

(iii) obtained not less than 40 per cent. of the possible marks in each subject in the final examination;

(iv) obtained in the final year not less than 40 per cent. of the possible marks for home work and for laboratory work and records respectively in each subject for which such marks are to be awarded under the approved scheme;

(v) obtained in the final year not less than 50 per cent. of the grand total of possible marks. The possible marks in the final theoretical examination should constitute 40 per cent., and in the final practical examination 30 per cent. of this grand total; the remaining 30 per cent. should be the possible marks for home work and for laboratory work and records for the final year.

The Institute and the Board may require the submission of the school or college records of attendance, the testimonies of studies, the laboratory notebooks, and the worked papers of any candidate to whom the issue of a certificate is desired.

11.—Distinction may be awarded to any candidate qualified to receive a Part-time Course Certificate in Chemistry (Higher), or a Full-time Course Certificate in Chemistry, or a Full-time Course Certificate in Applied Chemistry, who gains not less than 80 per cent. of the possible marks in the final examination in any subject of the final year of the course. Subject to the previous approval of the Institute and the Board, a candidate may take in such final examination any branch of chemistry or of applied chemistry studied in an earlier year of the course, but not in the final year, and may be awarded distinction in any branch so taken, provided the conditions of this paragraph have been fulfilled. The certificate will record any award of distinction.

12.—For the present the Institute and the Board may decide to issue certificates ir

* *A candidate failing to obtain the approved minimum percentage marks fo home work, or for laboratory work and records, or for examinations, in any class of uear prior to the final year of the cours* [illegible]

respect of a course taken by students who have not fulfilled completely the prescribed conditions, subject to the fulfilment of such conditions in regard to the last year of the course.

Submission of Schemes.

13.—Applications for the joint approval of the Institute and the Board of new and revised schemes must be submitted by the correspondent of the school or college in the first instance to the Board, from whom the necessary forms of application and all other forms required under these Rules may be obtained. Applications in respect of part-time courses should be made on Form 285 T. in duplicate, and those in respect of full-time courses on Form 286 T. in triplicate, not later than 30th September in the school year for which approval is desired. In subsequent years, unless alterations of an approved scheme are proposed by the school or college, or are required by the Institute and the Board, a renewed application for approval need not be submitted.

Duties of Examinations Officers.

14.—Each school or college must appoint an examinations officer to conduct on behalf of the school or college the necessary correspondence with the Institute or with the Board in connection with the examinations. The name and address of this officer must be notified to the Institute and to the Board.

15.—The examinations officer must advise the Institute on Form 287 T., not later than 31st January in the final year of each course, of the probable number of candidates expected to take the final examination in that year.

16.—Not less than two months before the date of the commencement of the examinations, the examinations officer must submit to the Institute for transmission to the assessors, draft examination papers for the examinations in the final years of the courses, and syllabuses of the work which will be completed during the year.

17.—At least one month before the date of the commencement of the examinations, the examinations officer must inform the Institute on Form 288 T. of the number of candidates entered for the examinations to be held in the final years of the courses, and must forward the fees to the Institute (see paragraphs 21 and 22).

18.—The examinations officer will be responsible for the conduct and supervision of the final examinations in conformity with these Rules and with the memorandum mentioned in paragraph 8, and for the safe custody of the examination papers as revised by the assessors and of the worked examination scripts.

As soon as possible after the scripts of the examination of the final year have been marked by the examiners, the examinations officer must forward them to the Institute, together with schedules of marks on Forms 289 T. and 290 T.

These schedules of marks will exhibit the records of the candidates for the several years of their courses in respect of

(i) attendance;
(ii) marks for home work, and for laboratory work and records;
(iii) examination marks.

The number of marks awarded in connection with each paper set, or in respect of home work and of laboratory work and records, will be stated on the schedules in each instance as a percentage of the maximum marks severally obtainable. Provision will be made on the schedule forms for any recommendations or remarks the teachers may wish to make.

19.—If required, the examinations officer must transmit immediately to the Institute, at any time within three months from the last day of the final examination, any candidate's laboratory notebooks for each year of the course, such notebooks to be attested duly by the teacher of each subject. During the same period he must be prepared to produce for the information of His Majesty's Inspector any such laboratory notebooks not in the custody of the Institute. In due course, any notebooks requisitioned by the Institute will be returned to the examinations officer.

20.—The Institute will issue to the examinations officer a list of the results showing the names of the successful candidates and any awards of distinction; and as soon as possible thereafter the certificates will be sent to the examinations officer. The school or college authorities must keep a register containing the names of the students of the school or college to whom certificates have been awarded. The Institute and the Board will keep registers of all certificates awarded by them under these Rules.

Fees and Correspondence with the Institute.

21.—For the present the following scale of fees has been adopted:—

(i) *Part-time Course Certificate.*—*Fee to be paid by the school or college authorities in respect of each group of candidates entered for a final examination of a senior or advanced course:* Guineas.

Senior: In respect of the first group	5
In respect of each additional group	$2\frac{1}{2}$
Advanced: In respect of the first group	5
In respect of each additional group	$2\frac{1}{2}$
Fee to be paid in respect of each candidate entering for a final examination	7/6

(ii *Full-time Course Certificate.*—Fee to be paid by the school or college authorities in respect of each group of candidates entered for a final examination in Chemistry or Applied Chemistry: Guineas.

Chemistry: In respect of the first group	10
In respect of each additional group	5
Applied Chemistry: In respect of the first group	10
In respect of each additional group	5
Fee to be paid in respect of each candidate entering for a final examination	15/-

22.—*All cheques or postal orders should be made payable to* The Institute of Chemistry and crossed Westminster Bank, Ltd.; and all correspondence with the Institute in connection with any matters arising out of these Rules should be prepaid, and should be addressed to—

The Registrar,
The Institute of Chemistry,
30, Russell Square,
London, W.C.1.

BOARD OF TRADE ANNOUNCEMENT.

DYESTUFFS ADVISORY LICENSING COMMITTEE.

Applications for Licences in July.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during July, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 371, of which 264 were from merchants and dealers. To these should be added the 24 outstanding on the 1st July, making

Granted—246 (of which 227 were dealt with within 7 days of receipt).

Referred to British makers of similar products—70 (of which 66 were dealt with within 7 days of receipt).

Referred to Reparation supplies available—50 (all dealt with within 2 days of receipt).

Outstanding on the 31st July—29.

Of the total of 395 applications received, 336, or 85 per cent., were dealt with within 4 days of receipt.

Board of Trade,
8th August, 1923.

LOWEST TEMPERATURE YET OBTAINED.

The lecture by Professor Dr. H. Kamerlingh Onnes on the *Lowest Temperature yet Obtained*, which is given in the Transactions of the Faraday Society for December, 1922, deals with a subject of very great interest. As soon as the efforts to liquefy helium had succeeded, it was of course investigated whether it could be solidified also. This was even tried on the same day on which helium had for the first time been seen as a liquid. The method used was that of evaporation under reduced pressure.

After describing the apparatus and preliminary experiments, Professor Onnes gives the following account of the crucial experiment.

"Early in the morning the preparation of 24 litres of liquid hydrogen was commenced, the previous day having been spent, on the one hand, in evacuating the apparatus and further putting it in working order, and, on the other hand, in preparing a sufficient quantity (more than 50 litres) of liquid air. Meanwhile, the following preparations were carried out: the helium circulation was further put in order; the pump, which had to remove the hydrogen from the helium liquefier at reduced pressure, was started; the space reserved for the liquid air used in cooling the hydrogen was next filled, and the liquid hydrogen space filled, after having been first cooled with dry cold hydrogen gas. At 12 o'clock the liquid helium could be syphoned over into the cryostat, after which we proceeded to cool this bath further by evaporation and refilling by means of the helium circulation. At 1 o'clock the condensation of the helium in the liquefaction apparatus could be

evaporation glass was filled up to somewhat above the double-walled cap mentioned earlier. At about 3 o'clock this helium had evaporated so far as to occupy only the lower part of the evaporation flask, the evaporation taking place first under the action of the auxiliary pump complex, later on under that of the combined high-vacuum and auxiliary pumps, which serve for the removal of the helium from the evaporation apparatus. The evaporation was further observed alternately with the naked eye and with the telescope of a cathetometer, the screens around the evaporation flask being kept shut as long as possible. Neither by means of the stirrer nor with the naked eye or with the telescope could anything be observed that pointed to the solidification of the helium, even at the lowest vapour pressure observed; the liquid retained its great mobility throughout."

Professor Onnes sums up this part of the research as follows: "Returning to the question of the solidification of helium, we come to the following conclusion: as there is provisionally no doubt that helium has a maximum density, and as it is even not solidified at a temperature below the half of that of the maximum density, we cannot escape the question whether helium will not *remain perhaps liquid, even if it is cooled to the absolute zero.*"

The result of the experiments recorded by Professor Onnes was the attainment of a temperature of 0.82 K., which he sums up as follows: "Taking into account the uncertainty of the extrapolation, it will be better to say that *the lowest temperature yet attained is some hundredths of a degree below* 0.9° *K.*"

"If it is considered that our knowledge of atomic structure renders improbable that another substance could be discovered or obtained in another way, more volatile than helium, then the limit indicated would seem an absolute one set to us in the obtaining of yet lower temperatures.

We cannot accept such a limit otherwise than as a provisional one. There are even now definite problems which require to be treated in the domain beyond the seemingly impenetrable barrier. A simple example is the question whether a metal such as gold can be made super-conductive by cooling it more than we have been able to do. This kind of problm reminds us of the problem of the liquefying of the permanent gases. They withstood the efforts of the great experimenter whose glorious name it attached to your Society. Half a century later, the liquefaction of hydrogen, the most incoercible gas with which Faraday had operated, was the brilliant achievement of the latest of his successors in office at the Royal Institution: Sir James Dewar. We may feel sure that the difficulty which has now arisen in our way will be overcome also, and that the first thing needed is long and patient investigation of the properties of *matter at the lowest temperature we can reach.*"

"The Vacuum-Spark Spectrum of Silicon," by R. A. Sawyer and R. F. Paton.—(*Astrophysical Journal, June,* 1923.)

The most recent work on the spectrum of silicon was done by Sir William Crookes in 1914. He succeeded in obtaining some rather pure samples of silicon, and using a condensed spark between electrodes of this silicon, photographed the spectrum with a prism spectrograph. The rapid oxidation of the silicon made it very difficult to maintain the spark, and necessitated long exposures. His work covered the region λ 6500 to λ 2100, and he published the wavelengths of 43 lines, including most of the lines previously recorded. This investigation was the most thorough work that had been done on silicon up to that time. Since the work of Crookes, Fowler has mentioned observing four lines in the visible region of the spectrum, not previously observed; and McLennan has extended the investigation into the extreme ultra-violet, cataloguing some seventeen additional lines.

A comparison of the results of all the work that has been done on silicon brings out the fact that no two observers have the same list of lines, and also shows that, even in the lines that have been recorded by several observers, the disagreement in wave-length seems almost unaccountably large. This disagreement may be partly accounted for, however, by the fact that many of the silicon lines are especially broad and hazy when produced at atmospheric pressure.

With the discovery of the vacuum-spark, a new source of light became available that seemed to have particular advantages in this problem. The use of the vacuum-spark in extending the spectrum into the extreme ultra-violet, had given results which led to the expectation that it might give new information in the rest of the spectrum. With this in mind, it was decided to photograph the vacuum-spark of silicon in

the region covered by Crookes, hoping that the results might give more accurate information concerning the wave-lengths of some of the lines, and even add to the already known list. In adapting the vacuum-spark to silicon, it was found necessary to use high voltage and extremely good vacua; but once obtained, the spark was brilliant, of a reddish yellow colour, and resembled the vacuum-spark of carbon.

A description of the apparatus used and tables of the observed lines are then given, of which the following is the author's abstract:—

Vacuum-spark spectrum of silicon λ 6700 — λ 2100. Silicon electrodes less than a *millimeter apart were mounted* in a suitably designed brass box with a quartz window, the best obtainable vacuum was produced, *and a highly condensed spark* was obtained by the use of 70,000 volts. Lines of iron, aluminum, calcium and oxygen and the strongest lines of hydrogen, nitrogen, copper, zinc and titanium appeared as impurities. The wave-lengths of 227 lines attributed to silicon in the region λ 6700—λ 2100, together with the measurements of other observers, are given in Table 1. An additional 75 lines, listed in Table 2, are given as doubtful, since they were faint lines appearing on only one plate. In the intervals, λ 6700—λ 5500 and λ 4070—λ 5500—λ 4070 and λ 3400—λ 2100 to λ 3400, the wave-lengths are believed to be accurate to within 0.2A, and in the intervals within 0.1A.

X-RAY PROTECTIVE MATERIALS.

By G. W. C. Kaye, O.B.E., M.A., D.Sc., and E. A. Owen, M.A., D.Sc., The National Physical Laboratory.

(From a Paper read at a Joint Meeting of the Physical Society of London and Röntgen Society.)

The steady addition to the already lengthy list of casualties to hospital and other X-ray workers led to the formation nearly two years ago of an X-ray and Radium Protection Committee (under the chairmanship of Sir Humphry Rolleston), which drew up a series of recommendations for the better protection and general improvement of the working conditions of the operator. These recommendations have resulted *in a large number of* X-ray protective materials being submitted for test to the National Physical Laboratory, which from the outset agreed to work in co-operation with the Committee, and has inspected the X-ray departments of many hospitals from the point of view of the Committee's recommendations.

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It is well known that the absorption of an atom is greatest for those X-rays which have wave-lengths slightly shorter than one or other of its characteristic radiations, and partly with this in mind it was thought that it would be of value to ascertain the protective efficiencies of the various materials which are commercially available for the purpose of affording protection to the radiologist. Among these are sheet lead, lead impregnated rubber, lead glass, and various wall compositions such as barium-sulphate plasters, &c. *The choice of one or other is* normally dictated by considerations such as dielectric strength, portability, electrical and thermal conductivity, and not least by price.

Protection may be afforded in a variety of ways in practice. For example, by mounting the tube in a surrounding tube box suitably designed to permit the freedom of movecent desired, or where this is impracticable the operator and his controls are situated behind a screen or wall which is constructed to give the necessary protection. Less frequently and conveniently the operator is "armoured" and wears protective aprons, gloves, face mask or goggles.

To the inexperienced the practice of *speaking of percentage absorption may* be misleading and calculated to give a wrong impression of the value of a protective *material. It is not always realised how* rapid the rate of absorption is with thin layers, and how slow with thicker layers. *For example,* in the case of tungsten X-rays generated at 120,000 volts, a sheet of lead only 0.1 mm. thick absorbs as much as 80 per cent. of the radiation, whereas a sheet 2 mm. thick only increases this figure to 99.4 per cent.

For simplicity, therefore, the Protection Committee recommended that the protection afforded by a material should always be referred to in terms of the equivalent thickness of lead. This use of lead as a standard of reference, while not wholly free from objection, is very convenient for the approximate accuracy which suffices in practice, especially in dealing with composite or laminated materials as the lead values of

the several layers can be regarded as additive. The Committee laid down certain thicknesses of lead which it regarded as the minima which should be employed under specified conditions; and, in view of the very unsatisfactory conditions which prevail in the majority of X-ray installations in this country, we have been led to put on record some of our measurements in this connection.

Material.	Density.	Lead Equivalent.
Lead Rubber—(60 different samples)	3.7 to 6.5	0.25 to 0.45
Lead Glass—(40 different samples)	3.2 to 4.1	0.12 to 0.20
Metals—		
Aluminium	2.7	0.011
Brass	8.4	0.25
Steel	7.8	0.15
Miscellaneous—		
Water	1	0.004
50 per cent. red lead, 50 per cent. litharge	—	0.3
Ordinary rubber	1.2 to 1.7	0.02 to 0.05
Concrete—		
4 stone chippings, 2 washed sand, 1 cement	2.1	0.012
4 clinker, 1 cement	1.5	0.010
4 granite, 1 cement	2.1	0.013
Roman mortar	1.5	0.009
20 chalk, 1 cement	1.6	0.011
6 sand, 1 lime	1.8	0.009
Coke breeze	1.0	0.004
Bricks—		
Fletton brick (red)	1.6	0.010
Stock brick (yellow)	1.4	0.008
Diatomaceous brick	0.6	0.003
Protective Wall Plasters—		
(1) 55 p.c. Native $BaCO_3$, 45 p.c. $CaSO_4$	2.0	0.001
(2) 33 p.c. $BaSO_4$, 33 p.c. sand, 33 p.c. cement	1.5	0.048
(3) 33 p.c. coarse $BaSO_4$, 33 p.c. fine $BaSO_4$, 33 p.c. cement*	2.3	0.12
Woods—		
Ash	0.73	0.0013
Balsa	0.096	0.0001
Bass	0.48	0.0005
Fir	0.52	0.0008
Mahogany	0.49 to 0.68	0.0006 to 0.0011
Oak	0.65	0.0008
White Pine	0.47	0.0006
Pitch Pine	0.53 to 0.56	0.0008
Spruce	0.41 to 0.43	0.0004 to 0.0006
Teak	0.58 to 0.76	0.0006 to 0.0011
Walnut	0.64	0.0008

* Mixture suggested by Mr. P. J. Neate.

Incidentally, sheet lead is commercially described and sold by its weight per superficial foot. "2lb. lead" referring to sheet lead weighing 2lb. per sq. foot. In this connection the following table may be useful:

Weight.	Thickness.
2 lb. lead	0.8 mm.
3 ,,	1.25 ,,
4 ,,	1.7 ,,
5 ,,	2.15 ,,
6 ,,	2.6 ,,
7 ,,	3.05 ,,
8 ,,	3.5 ,,
9 ,,	3.95 ,,
10 ,,	4.3 ,,
11 ,,	4.75 ,,
12 ,,	5.2 ,,

There is some tendency at the present time to employ baryta and other plasters in lieu of lead. We give the lead equivalents of three of these plasters. It may be remarked, to take the case of mixture No. 2, that 60 mm. (nearly 2½ inches) thickness will be required to give the protection of 3 mm. of lead, and that the weight of the plaster is nearly three times that of the lead. These figures would be more favourable for plaster No. 3. We have no knowledge of the costs of these plasters as compared with lead, nor of the cost of the labour involved in erectiou.

Certain plasters have been devised containing iron turnings. They possess no special merit as regards absorption, and the tendency to rust is a disadvantage.

Tube Boxes.

Protective tube boxes, if constructed of lead, have to be of dimensions sufficiently generous to prevent sparking between the bulb and the box. If, however, the tube box is required to be in close proximity to the bulb, the former commonly takes the form of a lead glass bowl, or, alternatively, a wooden box with several layers of lead-rubber lining or wrapping. The open glass bowl is open to grave criticism: it is constructed of lead glass, usually affording, as our measurements show, a total protection of from 0.5 to 0.7 mm. lead; but in many directions, owing to its design, it affords no protection whatever. In our experience, where this type of chield is alone employed, it is often possible to take a radiograph of the hand in any part of a room where a provided with some kind of cover and the material increased in effectiveness.

The type of double hemispherical shield supplied for radiator Coolidge tubes is much better, in that it completely encloses the tube. The different shields (whether tinted blue or yellow) which we have tested, have a lead equivalent of about 0.2, the total protection provided ranging between 1.2 and 1.5 mm. lead. The Protection Committee recommends not less than 2 mm. for exciting voltages below 100,000. We refer again to the question of lead glass in connection with protective windows, etc.

Different makes of lead rubber differ in protective value by 100 per cent., and the importance of this fact should be stressed. Care should be taken that the lead rubber is not cut away locally when the box is being constructed.

The choice of lead rubber or lead glass in preference to lead sheet is usually dictated by the fact that the former are electrical insulators, at any rate to a limited extent. The resistivity of lead rubber is usually of the order of several thousand megohm centimetres. The insulating value may be greatly improved by including a layer of micanite, ordinary ruhber, or other suitable insulator among the layers of lead rubber.

Measurements of the dielectric strength have been made in the Electrical Department of the Laboratory on a considerable number of samples. Two circular electrodes 1½ in. in diameter with rounded edges were placed in contact with opposite sides of the material, an alternating potential of approximately sine wave form being applied and steadily increased from zero until the material punctured. For good specimens of lead rubber the breakdown voltage was about 5,000 to 12,000 R.M.S. volts per millimetre thickness. In otber cases the values were a good deal less, and on occasion the material acted as a conductor. For lead glass the values ranged from about 5,000 to 9,000 R.M.S. volts per millimetre.

One other point may be referred to. In a prolonged run, especially with a Coolidge tube ,a great deal of heat has to be got rid of, and it is usually advisable to provide for ventilation of the tube box; in that event the openings should be properly safeguarded from a protection standpoint. A knowledge of the thermal conductivity of the several protective materials may be useful in this connection. Measurements at the Labora-

onductivity at room temperature are as ollows in c.g.s. Centigrade units:—

Woods (various)	About	0.0003
Ordinary rubber	,,	0.0008 to 0.0011*
Lead rubber	,,	0.0003 to 0.0007
Lead glass	,,	0.002
Lead	,,	0.08

* Depending on the mineral content.

If considerations of weight are of first importance, then lead sheet is almost always he lightest among the protective materials commonly employed for tube boxes. For xample, the protective values of lead rubber range between about 0.25 and 0.55, and he densities between about 3.7 and 6.5. On he average, lead rubber is about 10 per ent heavier than sheet lead, affording the ame protection, though it may be as much s 25 per cent. and as little as 5 per cent.

Similarly with lead glass, the protective alues commonly lie between 0.12 and 0.20, nd the densities between 3.2 and 4.1. On he average, lead glass is about twice as eavy as sheet lead, affording the same rotection, the figures ranging from about .75 to 2.5.

These results (as with those for the reen materials) are, of course, predictable, s it is known that a heavy atom is ordiarily much more absorbent than a light. 'or the same reason. in the case of two omposite materials, each containing a mixure of atoms and having the same density, e one containing a higher proportion of eavy atoms will usually have a higher aborption factor. With lead rubber the lack proportionality between density and lead alue is sometimes pronounced, and of two amples the one with the lower density may ave the higher lead equivalent.

Diaphragms of the iris type are often ited to tube boxes. The leaves are usually uch too transparent. They should prode protection equal to not less than 3 m. of lead, and the simpler rectangular aphragm with two motions is a more actical job.

PROCEEDINGS AND NOTICES OF SOCIETIES.

IRON AND STEEL INSTITUTE.

MILAN MEETING, SEPTEMBER 17 & 18, 1923.

In accordance with previous announcements, the Autumn Meeting of the Iron and Steel Institute will be held at the Chamber of Commerce, Milan (via Mercanti 2-4), on Monday and Tuesday, September 17 and 18, commencing at 9.30 a.m. on each day.

At the conclusion of the meeting visits have been arranged to Florence, Rome, Piombino, Leghorn, Genoa and Turin.

The following is the list of papers which it is expected will be submitted to the meeting:

C. R. AUSTIN, *Alloys in the Ternary System Iron-Chromium-Carbon.*

E. D. CAMPBELL, W. L. FINK, and J. F. ROSS, *The Iron-Iron Carbide Equilibrium in Dry Hydrogen at 950° C.*

E. D. CAMPBELL, J. F. ROSS, and W. L. FINK, *The relative efficiency of Dry and of Moist Hydrogen on the Decarburisation of Steel at 950° C., and the effect of Hydrogen on the Phosphorus Content.*

C. A. EDWARDS and L. B. PFEIL, *A Note on Coarse Corrugation in Mild Steel Sheets*

G. E. FALCK, *The Iron and Steel Industry of Italy.*

F. GIOLLITI, *The Complex Action of Manganese and of other so-called Deoxidising Agents in the Manufacture of Steel.*

W. T. GRIFFITHS, *The Change Points in some Nickel-Chromium Steels.*

W. H. HATFIELD, *The Influence of Nickel and Chromium upon the Solubility of Steel (in relation to Corrosion).*

CESARE MARTELLI and TITO SOTGIA, *The Iron Ore Mines of Nurra (Sardinia).*

A. PORTEVIN, *The Morphology of Pro-Eutectoid Cementite.*

A. PORTEVIN, *The Corrosion Cracking of Steel under the Influence of Internal Stresses.*

S. H. REES, *The effect of Low Temperature Annealing on some Mechanical Properties of Cold Drawn Steels.*

H. STYRI, *Theory and Practice of Steel Refining.*

C. VANZETTI, *The Manufacture of Heavy Steel Castings from Small Converters.*

H. C. WANG, *Grain Growth in Iron and Steel.*

28, *Victoria Street, London, S.W.1.*
August 13, 1923.

THE CHEMICAL SOCIETY.

It has been decided to separate the Transactions and the Abstracts, and from January, 1924, these will appear monthly as distinct volumes. A new feature in the Transactions will be the inclusion from time

to time of "Notes" dealing with, for example, improved methods of preparation, *modification of standard apparatus, and* other matters requiring only brief notice.

"THE CHEMIST IN RELATION TO THE SAFEGUARDING OF INDUSTRIES."

This, the last of my headings, has reference to two recent Acts of Parliament, which you will all know something about, namely, the Dye-Sstuffs Import Regulations Act of 1920, and the Safeguarding of Industries Act of 1921. The former prohibits the importation into this country of synthetic organic dyestuffs, etc., except under licence from the Board of Trade. Of course, all that is to the good so far as the protection of the home chemist is concerned. I think the Safeguarding of Industries Act also will be found, in the long run, to be for the benefit of the chemist rather than otherwise. That Act imposes a duty of one-third the value of the goods upon certain enumerated articles, among which are found nearly all the mechanical apparatus of the chemist, and, in addition, practically all the raw material which the chemist uses in his researches. At first sight it might be thought a little against the interest of the chemist that he should have to pay more for his raw materials and for his apparatus, by reason of these high import duties, because, I suppose, there are many of these things which, even now, can only be obtained from abroad; but in the long run it must be to the benefit of the chemist and the Empire that the production of all these things at home should be promoted. When the crisis came in 1914 we had not got, and had not the facilities for producing, many essential substances and apparatus. If we can make these things at home, then not only will there be increased employment of chemists, but when we come to another crisis we shall be better provided in that respect than we were then. I think the provisions of this Act will help to bring that about.—(*From the Lecture recently delivered before the Institute of Chemistry, by Evan James MacGillwray.*)

A SENSITIVE ELECTROSCOPE.

By Takeo Shimizu.

(*Jap. J. Phys.*, I. (1922), 107-111, with 2 fig.)

The electroscope described in this paper is a modification of that of Mr. C. T. R. Wilson. It consists of a fine silvered glass fibre suspended freely at the centre and four metallic plates, two large and two small, placed symmetrically on both sides of it. The larger ones are about as long as the fibre and stand vertically facing each other on each side. The smaller ones stand also vertically but below the locus of the lower end of the fibre at some distance from each other and situated between the fibre and the respective larger plates. The two plates on either side form a single electric system and the two systems are kept at the same potential, while the fibre is charged to a high auxiliary voltage. When the electroscope is to be used, one of the systems is isolated and connected to the object. The two inner smaller plates play the part of a stabilizer and a comparatively high sensibility can be obtained in virtue of their presence. In favourable cases a sensibility of about 5,000 scale divisions per volt was obtained, although such a sensibility may not be suited to the deflection method, owing to various difficulties. But as the instrument keeps a very constant zero position by its design, it may be employed as a sensitive zero indicator.

ON THE STRUCTURE OF THE SECOND CYANOGEN BAND.

By Junzo Okubo.

(*Sci. Dep. Tôhoku Imp. Univ., Ser.* I., XI. (1922), 55-86, with 1 pl.)

The second cyanogen band having the first head at λ 4216 A emitted by the ordinary carbon arc in air was examined. The instrument used in this experiment was a concave grating of a radius of curvature 6.55 m. with 5,910 lines per cm. and 77,273 lines in all. Acheson regraphited carbon rods were used. The wave lengths of 1,555 lines lying between λλ 4216 and 3900 A were accurately determined in the international unit. The second band contains many doublets, some of which have been described as singlets by many previous investigators. Three remarkable series were traced, and their insensity distributions described. The wave lengths of the heads of four bands produced by cyanogen were measured, and it is shown that there exist some simple relations among the wave numbers of consecutive heads.

ON THE BAND SPECTRUM ASSOCIATED WITH HELIUM.

By Yutaka Takahashi.

(*Proc. Phys.-Math. Soc. Japan*, Ser. III., IV. (1922), 187-194).

In order to explain the origin of Fowler's series of double headed bands of helium, the author assumes that when a discharge is passing through a helium tube there are produced some short living, unstable molecules, each consisting of two positive nuclei, which are liable to vibrate along the line joining them and to rotate as a whole about the middle point of the line, and electrons, one of which is removed from its stable orbit to another of a higher quantum number. By applying the quantum theory to this model, it is shown that the frequency ν of the radiation is of the form:

$$\nu = A(m_1, n_1, m'_1, n'_1) - A(m_2, n_2, m'_2, n'_2),$$

where m and n are the radial and azimuthal quantum numbers respectively due to the electron, and m' and n' are respectively *those due to the nuclei. Different values* of n' correspond to the individual lines of each band, and different values of m' give rise to the series of the bands, which actually appear as double headed bands as m' is limited to zero and 1 owing to the instability of the molecule. Two different combinations of m and n such as

$$m_1 = 1+s,\ n_1 = 2,\ m_2 = 1,\ n_2 = 1,\ s = 0,\ 1, 2, \ldots$$

and

$$n_1 = s,\quad n_1 = 3,\ m_2 = 0,\ n_2 = 2,\ s = 0,\ 1,\ 2, \ldots$$

are responsible for the two series of the double headed bands detected by Fowler.

ON THE LANTHANUM VIOLET BANDS AND THE ASSOCIATED LINES.

By Junzo Okubo.

(*Sci. Rep. Tôhoku Imp. Univ., Ser. I.*, XI. (1922), 95-104, with 1 fig.)

The structures of the band spectrum emitted from lanthanum nitrate put into a carbon arc were studied with a large concave grating. The wave lengths of the edges of the bands, some of which had been missed by previous investigators, were determined in the new international unit, and the opinion was confirmed that each band is of double structure. In the light of the quantum theory, the bands may be explained as due to molecular rotations caused by line emissions.

BRITISH STANDARDISED STEEL SAMPLES ISSUED JOINTLY BY THE IRON AND STEEL INSTITUTE AND THE NATONAL PHYSICAL LABORATORY.

The Standards at present available are:
No. 1.—Sulphur (S. = 0.027 p.c.).
No. 2.—Sulphur (S. = 0.071 p.c.).
No. 3.—*Phosphorus* (P. = 0.029 p.c.).
No. 5.—Carbon (C. = 0.65 p.c.) Acid O—H Steel.
No. 6.—Carbon (C. = 0.10 p.c.) Basic O—H Steel.

These Samples are supplied, post free, at 21s. per bottle containing 50 grammes, together with certificate of Standardisation. They can be obtained, by sending order with remittance, direct from:—

The National Physical Laboratory,
(Metallurgy Dept.), Teddington,
Middlesex;

or by post or personal application from:—

Dr. C. H. Desch, Dept. of Applied Science, The University, Sheffield.

Dr. C. A. Edwards, The University College, Swansea.

Col. E. L. Johnson, Cleveland Technical Institute, Middlesbrough.

Mr. D. A. MacCallum, West of Scotland Iron & Steel Institute, 93, Hope Street, Glasgow.

Other Samples are in preparation and will be issued when ready.

These samples can also be obtained from all Chemists dealing regularly in laboratory ware.

NOTICES OF BOOKS.

The July number of the *Bulletin of the Bureau of Bio-technology* contains the following papers:—

The Occurrence and Effects of Wood-destroying Fungi in Coal Mines.

The Examination of Bacteria in Beer Deposits.

Water Softening for Spraying Purposes.

The Suppression of Insect Pests and Fungoid Diseases.

The number also contains an Index for Vol. 1. A copy of this Index may be had on application to Messrs. Murphy & Son, Ltd., Cedars Laboratories, Sheen Lane, Mortlake, London, S.W.14.

The Paper-makers' Directory of all Nations, published by Dean & Sons, Ltd.,

27, *King Street, Covent Garden*, price 21s., will be found of value to those interested in paper and the allied trades.

The subject matter is arranged in alphabetical order for easy reference, and contains a large number of trade headings and a classified index to commercial prospectuses.

The work has been produced with the usual thoroughness and care, and cannot fail to be of interest and value in the paper trade.

Practical Bacteriology for Chemical Students, by DAVID ELLIS. Longmans, Green & Co., 39, Paternoster Row. Price 4s. 6d. net.

This valuable little book consists chiefly of exercises which are followed in the author's classes in the University of Glasgow, and in the preface it is pointed out that there are many avenues in chemical research that are closed to the investigator owing to lack of knowledge of the elementary principles of bacteriology. The object of the book is to give to the trained chemist sufficient guidance to enable him to master the general principles of the subject. The exercises are so arranged that they can easily be followed by any who desire a grounding in the general principles of bacteriology.

The book opens with a chapter devoted to descriptions of the apparatus used in bacteriological research, and it is very thoroughly illustrated with both drawings and diagrams. In chapter 2 the exercises commence with the preparation of nutrient gelatine and agar-agar. Chapters are given on the staining of bacteria, identification and staining of spores, isolation of bacteria from soils, examination of drinking water and sewage, and many details connected with practical bacteriology.

The work is written in simple language, and is easy to follow. It is quite evident that the author is not only a thorough master of the subject, but also possesses the great qualification of lucid explanation. The book is well indexed, and contains a table of contents. It will be found of very great value to all interested in the subject of which it treats.

BOOKS RECEIVED.

Physikalalische Chemie: I., *Chemisch Reine Stoffe*: II., *Losungen*: von DR. ALan der Universtat Bonn. Pp. VIII. + 107 1923. Verlag von Theodor Steinkopff, Dresden and Leipzig.

Practical Physical Chemistry, by ALEXANDER FINDLAY, M.A., D.Sc., Professor of Chemistry, University of Aberdeen. Pp. XVI. + 298. 4th Edition, 1923. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 7s. 6s. net.

Petroleum Technologist's Pocket-Book, revised by ARTHUR W. EASTLAKE. Pp. 546. 1923. Messrs. Charles Griffin & Co., Ltd., Exeter Street, Strand. 15s. net.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

19834—Buss Akt-Ges.—Apparatus for production of anhydrous tin chloride. Aug. 2.

19592—Constant, G.—Reduction of metal oxides. July 31.

19600—Naugatuck Chemical Co.—Preparation of reaction product of acetaldehyde and aniline. July 31.

19977—Weizmann, C.—Filtration of solutions, etc. Aug. 3.

Specifications Published this Week.

200651—Thomas, J., and Scottish Dyes, Ltd.—Method of producing anthraquinone sulphonic acids.

200902—Du Pont de Nemours and Co., E. I.—Process of manufacturing cyanides.

179951—Heinemann, A.—Process of manufacturing formic aldehyde.

189107—Barrett Co.—Manufacture of aromatic aldehydes.

190123—Soc. Chimique des Usines du Rhone.—Process of manufacture of the calcium salt of acetyl salicylic acid.

Abstract Published this Week.

199073—Chlorinated montan wax.—Stinnes, H. (Firm of), Mulheim, Germany.

The chlorination of montan wax, obtained by extraction of lignite with solvents, is effected in the presence of water, organic solvents being absent. The montan wax is first suspended in water or an alkaline solution, such as caustic soda solution or milk of lime, and gaseous chlorine passed in; or a suspension of montan wax in hydrochloric acid is treated with chlorate, for example, by the addition of potassium chlorate in the *solid form or in aqueous solution*. The reaction may be accelerated by the presence of catalysts, such as ferric chloride. The products are useful for insulation purposes, as a substitute for beeswax, and in the preparation of floor polishes, boot creams, &c.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, [illegible]

THE CHEMICAL NEWS,

VOL. CXXVII. No. 3307.

M. CAREY LEA, CHEMIST.

1823—1897.

BY EDGAR F. SMITH, UNIVERSITY OF PENNSYLVANIA.

A hundred years ago (1823), Matthew Carey Lea was born. His contributions to chemistry brought him honour and distinction among his colleagues throughout the world, so that pause may well be made to let them pass in brief review. Few chemists of his day knew him personally; in fact, students of chemistry in this country would probably not give his name if called upon for a list of American scientific worthies, hence a brief consideration of his achievements will be in order. They will augment our pride in the men who wrought in chemistry before these very modern days when, on all sides, there is heard a demand for research, forgetting that the past in chemistry, even in this country, can present many excellent examples of earnest devotion to the purely scientific aspects of chemistry.

Carey Lea (as he was usually called) was a true researcher. His first study, published in 1841, related to the Southern Coal Field of Pennsylvania. His father had expressed the thought that "the hard or highly carbonised anthracite of the eastern end of the Southern coal field changes to bituminous in the western end by nearly regular gradations." The results obtained by Carey Lea showed "that the bituminous qualities of the coal increase with considerable regularity from Tamaqua (the easternmost end) to Rattling Run (the westernmost extremity)."

Lea did this work when he was but eighteen years old, in the laboratory of Booth, Garrett and Blair, where he had gone to familiarise himself with practical chemistry. He loved scientific pursuits. He never went to school or college. His remarkable training was "through the best private tutors procurable." His intellectual powers were immense. He knew literature, mathematics, languages, and the natural and physical sciences.

After his first venture into experimental chemistry he gave himself to the study of law, and was admitted to the Bar in 1847, at the age of 24. But this profession he abandoned and journeyed to Europe, hoping to regain his health, which had become precarious. However, his hopes were not realised, and he returned to the old laboratory on Arch Street (Booth, Garrett and Blair) with the view of perfecting himself still further in chemistry.

In his earlier days in the Booth, Garrett and Blair laboratory, he had as fellow student in chemistry his brother, Henry Charles Lea, who later in life was regarded as the first and greatest of modern scientific historians. He was the author of seventeen volumes on Mediaeval History and Law. And this same younger brother, at the age of twelve years, was busily engaged in a study of manganic oxide; the results appearing in May, 1841, in the *American Journal of Science*. The paper is interesting and valuable. Few chemists, at the age of twelve, have ventured forth with such an excellent production. He began:

"The peroxide of manganese (Mn_2O_3) has never been investigated, as its existence has, until lately, been questioned by some of the first chemists in Europe, and the tendency of its salts to convert themselves into proto-salts, contributed to render it problematical whether it was not merely the protoxide disguised."

Interrupting this digression, it may be remarked that when Carey Lea finally left the Booth, Garrett and Blair laboratory, it was to enter a private laboratory installed in his home at Chestnut Hill. There nearly all his later experimental work was done. But the notebooks of that work were, upon his death, destroyed in accordance with his own desire. Among these was a list, preserved from boyhood, of the chemicals and apparatus imported by his father for his use.

Lea showed a decided penchant for chemical theory. He was much concerned about the chemical properties of atoms and their numerical relations, undertaking to show "that the number of 44.45 plays an important part in the science of stoichiometry, and that the relations which depend upon it are supported, in some cases at least, in a remarkable manner, by analogies of atomic volume." This relation was found to extend to no less than forty-eight of the elements. The first germs of the periodic law, not, however, clearly enunciated, were in his thoughts. And in 1875 and 1876 he published two ingenious papers on the Colour Relations of Ions, Atoms and Molecules.

As early as 1857 Lea became interested in picric acid, giving a new method for its preparation and also descriptions of many new

salts, including the urea and quinine picrates. He concluded that picric acid was wholly unreliable as a test for potash, and, indeed, a better test for soda.

Shortly after the beginning of the Civil War he advised the United States Government that picric acid would be an explosive of greater power than black powder. Its *smokelessness appealed to him as an* advantage. The Federal Government, however, failed to appreciate the importance of using an *explosive outranging* anything in use at the time, and it was not until fifty years after that high explosives on a picric acid basis were adopted.

To separate the ethylamines Lea recommended the use of their picrates: triethylamine picrate being extremely insoluble, diethylamine extremely soluble, and ethylamine intermediate. He gave some consideration to the methyl bases and the preparation of urea—with good and definite results. By the interaction of naphthylamine and sulphuric acid he obtained ionaphthine—a ne wcolouring matter. On dropping a bit of gelatine into a mercuric nitrate solution the latter gradually assumed a deep red colouration—a new and valuable test for gelatine. Lea did not regard as reliable the determination of the melting point of methyl oxalate as a means of ascertaining the purity of methyl alcohol (containing ethyl alcohol). For the detection of prussic acid he suggested the addition of a ferrous salt containing a little uranic nitrate, when a beautiful purple coloured precipitate was formed. A great increase of delicacy in the reaction between starch and iodine was observed by Lea on adding chromic acid to the solution. He also wrote on a new *method of determining the relative affinities* of certain acids which was based on the amount of base which it can retain in the presence of a strong acid selected as a standard of comparison for all acids. Two new methods were proposed by Lea for the reduction of platinic to platinous chloride—one by the action of potassium sulphite, the other by that of alkali hypophosphites. He also demonstrated that a solution of iodoquinine affords a means of detecting free sulphuric acid, even in traces, in presence of combined sulphuric acid.

In a collection of miscellaneous pamph lets, once the property of Carey Lea, are several contributions of Carl Claus on "Chemie der Platinmetalle," fully annotated in the marginal way, thus revealing and Lea had more than ordinary interest in this very important group. He studied its members with care, using material furnished by his former teacher, James Curtis Booth. Among the new facts disclosed by him is the use of oxalic acid for the first *time in purifying ammonium iridium* chloride, and the discovery of a reaction for ruthenium which proved most helpful. If *to a solution of sodium hyposulphite there* be mixed ammonia and a few drops of ruthenium sesquichloride, a magnificent red-purple liquid will be produced, which, unless quite dilute, will be black by transmitted light. The chief value of this test was found to lie in the fact that it is capable of detecting ruthenium in the presence of iridium. Lea thought it valuable in testing the purity of iridium for "if the suspected iridium salt be boiled with hydrochloric acid, and ammonia added until the liquid assumes a pale olive colour, then, on *adding the* hyposulphite and boiling, any increase of colour indicates the presence of impurity. If the liquid acquires a red colour, ruthenium is present; if a wine colour, platinum is probably present, and if brown, palladium is indicated." Lea applied ruthenium sesquichloride to detect sodium hyposulphite.

An adequate idea of Lea's voluminous work, as investigator, cannot be given in a narrow compass, such as this article. The student should turn to the pages of the *American Journal of Science*, beginning with the year 1858, and read forward to the year 1897, then some deduction may be drawn of the vastness of Lea's labours. These papers deserve very careful study. There is such an abundance of originality in them. In the volume of *The Chemical News* for 1862 will also be found four additional contributions. A review of all this material would furnish many topics for seminar consideration.

But the greatest of all Lea's efforts to extend the borders of human knowledge are those dealing with the chemistry of light; for in photochemistry he was a true pioneer. He blazed the way. Quite early in his life the startling invention of photography from the hands of Daguerre drew his most thoughtful attention. He saw its enormous possibilities and promptly began a fundamental study of its chemistry, also its physics, and its practical value. From this study came the only book he ever wrote, entitled "Photography." It passed through two editions, and was everywhere regarded as standard. Its perusal reveals

the masterful mind which prepared it. It is absolutely scientific in its discussion of the problems of photography. But, foreign scientists were first in recognising the value of Lea's efforts in this new field. They declared them to have a lasting, permanent value, in scientific photography, and that they were all fundamentally important in physico-chemical research. Indeed, these researches were genuine classics. For colloid chemistry they possessed an ever-increasing interest and value. Lea's "colloid silver" and "photo-haloids" were translated and heralded abroad as epoch-making studies. Perhaps it is somewhat of a reflection upon American chemists that the importance of these studies was first emphasised by foreign chemists. However, other American labourers in the field of chemistry had their remarkable discoveries pass unnoticed, until attention was drawn to them by the regard in which they were held by co-workers in other lands, as for example—J. Willard Gibbs and his phase rule, Robert Hare and his classic work on the electric furnace, and others.

To be the discoverer of the amorphous forms of silver is no mean distinction. When these come under the eye of chemists enthusiasm is immediately kindled, and there arises an inquiry as to their discoverer.

As remarked, few chemists knew Lea personally. He was a recluse in a certain sense, for he rarely appeared in the company of scientists or other groups of men. Quietly, unostentatiously he laboured on very independently, until his contributions to purely photographic subjects reached the number of 300, to be found on the pages of the *American Journal of Science*, to which reference has already been made.

In addition to his numerous chemical papers, Lea published many others in the domain of physics. He further elaborated certain pieces of apparatus which proved helpful in laboratory work. And thus the course of his scientific endeavour proceeded, for he was a most industrious worker in all regions of his favourite science. He was a very acute observer. He knew the literature of chemistry, both past and present. He had an intense love of truth. He always had in hand the facts upon which he based expressed opinions. His opinion was recognised as the final opinion in photographic chemistry, both in this country and in Europe. He was likewise devoted to literature, the classics and art.

For one so eminent in his science he belonged to few scientific organisations—viz., the Franklin Institute and the National Academy of Sciences, to which he was elected in 1895.

An accident in his laboratory, in early life, so seriously injured one of his eyes that it eventually was removed. His devoted wife read to him for many years, so that he was able to keep up his interest in the current work of scholars at home and abroad.

Carey Lea was the son of Isaac Lea, a distinguished naturalist, who served as President of the Academy of Natural Sciences in Philadelphia, and of the American Association for the Advancement of Science. It was an old Quaker family into which Carey Lea was born, August 18, 1823. He was married twice, first to his cousin, Elizabeth Lea Jaudon, and after her death to Eva Lovering. Carey Lea died March 15, 1897.

The various apparatus owned by Lea was bequeathed to the Franklin Institute in Philadelphia.

The life story of Lea is most interesting. He was, indeed, a bright star in the chemical firmament of America!

THE CHEMICAL INDUSTRY OF JUGO SLAVIA.

The chemical industry of Jugo Slavia cannot be said to have reached a high state of perfection. It, nevertheless, possesses possibilities of considerable dimensions.

It may be pointed out that Jugo Slavia embraces old Serbia, Montenegro, Croatia, Carniola, and Dalmatia; it is also sometimes termed the kingdom of the Serbs, Croats and Slovenes. At present there is no chemical industry outside that portion of the country which was not formerly under Austrian rule.

In this region, various pharmaceutical preparations are made from the extractions *of certain plants. This is a branch of* chemical industry which might easily be extended in this country, which is well suited for the cultivation of many plants used for pharmaceutical purposes. At present the industry is almost exclusively confined to the preparation of perfumes.

In the north, at Ljubljana (Laibach), the local bauxite is exploited for making aluminium sulphate and alums. The metal is also produced in a limited amount. The salts manufactured are partly exported and partly consumed locally as mordants by the small dyeworks.

A beginning has also been made in the exploitation of the natural mineral resources of this district. In 1908 a kind of company, entitled "Wocheinit," was founded for mining the bauxite. This society holds all the mineral rights for the district between Bistrice and Jesenice.

During the war more than 6,000 tons of bauxite were mined. The output has since been restricted through lack of wagons, and also as a result of transport difficulties over the new frontiers.

This bauxite did not enjoy a good reputation, as it was supposed to contain a high percentage of silica, which would render its use by either wet or dry methods very difficult. The latest analyses indicate just the opposite, and it is shown that there are two kinds of bauxite. The first variety of Bohinske bauxite is said to be of the most suitable quality for the aluminium industry. It occurs in large masses on the slopes of the Julian Alps, and contains:—

Alumina	58-60	per cent.
Ferric oxide	6-10	,,
Silica	3.5- 4.5	,,
Titania	1- 2	,,

Vogar bauxite has seams which are ten to fifteen metres thick.

The second variety of bauxite is less pure, but is very suitable for making fireproof articles, and is found in quite separate shafts from the purer variety. It contains:

Alumina	52-56	per cent.
Iron oxide	10-16	,,
Silica	4.5- 5.5	,,
Titania	2- 3	,,

THE BRITISH CAST IRON RESEARCH ASSOCIATION.

Research Department.

General Research Work.—The work in connection with the various researches is progressing to such an extent that the Director proposes to issue forthwith reports upon the various results obtained. These will be found to be of very great interest to members.

Foundry Sand Research.—The Bureau, in their No. 2 Bulletin, are commencing a series of articles upon Foundry Sands, which will give members some very valuable data. The object of this research is to enable standards to be established to judge one of the most important factors in the successful production of castings.

Bulletins.—The Bureau Bulletin No. 1 has now been issued to members, and comprises over 100 pages of very valuable information. The Research Bulletin No. 3 is in the printers' hands for early issue, and Bureau Bulletin No. 2 is also ready for the printer. Members will recognise by the receipt of these Bulletins that the Association has carried out a very large amount of useful work.

Problems Sent in by Members.

During the past month members have sent in problems upon the following: Locomotive Injectors; Air compressing engine Cylinder liners; Annealing Malleable Iron; Porosity in Castings; Pan Mill Soller Rings; Mottled Castings; Spongy Trunk Slides; Cupro Nickel Ingot Moulds; Fluted Cast Iron Roll Moulds; Chilled Iron Rolls; Faulty cores in Castings; Cupola design.

The Bureau and Library.

The Bureau has been called upon to supply a large amount of data and information during the past month, and whilst there have been some cases where the required information was not in the Bureau, it was ultimately obtained from abroad, proving the great usefulness of the "Intelligence Service."

The Library Catalogue is now issued, and members will be able to use the Library to better advantage.

New books are continually being added. The following books have been sent for review in the Bulletin:—

Causes and Prevention of Corrosion, by A. A. Pollitt. Published by Benn Bros., Ltd., London.

Refractories for Furnaces, by A. B. Searle. Published by Sir Isaac Pitman & Sons, Ltd., London.

Engineering Non-Ferrous Metals and Alloys, by Dr. L. Aitchison and W. R. Barclay. Published by Henry Frowde and Hodder & Stoughton, London.

British Acetylene and Welding Handbook. Published by *The Acetylene and Welding Journal.*

Membership.

During the past month further new members have been elected. These include several large firms who recognise the value of the work of the Association. The membership badge is very generally used by members on their stationery, and it is reported that this has been of great value to several of the members.

THE GENERAL COUNCIL.

To fill a vacancy that has occurred on the Council, Mr. F. Fielding, of Messrs. Fielding & Platt, Ltd., Gloucester, has been elected to represent the counties of Gloucester, Hereford, and Monmouth. At the next annual meeting, nine members of the Council retire, eight of whom are offering themselves for re-election.

PROPAGANDA WORK.

It has been pointed out to the Council that the advantages of membership of the Association would be better understood if meetings were held at which the officers of the Association could attend and discuss the work and objects of the Association. The Council will be glad if Ironfounding Employers' Associations or any other secton of the indutry would arrange meetings, when the Director of Research and the Secretary will attend. Several meetings have already been held in various districts, when good results have accrued. It has enabled the officers to discuss with the employers the needs of the industry and the absolute necessity of such an Association. After all it should be remembered that the Association is the Ironfounders' Association. It is in their power, and to their interests, to make it a great success.

THE MALLEABLE CASTING INDUSTRY.

Unlike the malleable industry in this country, everything is being done in America to increase the production of malleable castings, and to obtain their adoption for every possible engineering use. Foremost of all, their malleable ironfounders firmly believe in research, and have practically all joined their Research Association and have standardised their products.

Secondly, they are proving to the engineer the superiority of malleable castings over drop forgings or stampings. Some time ago a complete collection of castings for railway purposes was furnished by members of the American Malleable Research Association. In addition to this exhibit a working demonstration was given to acquaint railway engineers with the properties of malleable castings. For this purpose a suitable punch press was installed, and was operated by an experienced operator. A supply of ⅝ inch cast iron plates was provided. They were punched with a ¾ inch hole and the holes were drifted until the diameter was increased to 1½ inches without injury to the plate.

A torsion machine was operated to show the resistance of malleable castings to repeated strains. Bars 1 x ¾ inch in cross section were twisted three times through 180°, and after each twist straightened to its original form. A further test was given in twisting a bar through 800° without fracture.

That malleable ironfounders in this country can produce castings equal to America is proved by some tests taken of castings made by a firm, who are members of this Association, when the tensile was 25.3 tons with elongation 14 per cent.

The Association consider these figures should be universal in the industry, if the malleable makers will join the Association and co-operate with it to obtain a general improvement in the castings the Association will be able to place before the railway and automobile engineers such reliable data as will convince them as to the advisability to use malleable work.

The Council of the Association, on their side, are doing all they can to bring back the malleable trade, but they must have the whole-hearted support of the firms themselves. The present time is the most opportune time to become members, and so prepare for the trade improvement when it arrives. Alterations in methods of production are difficult to carry out when the foundry is busy. The firms who have already joined are setting their houses in order preparatory to the busy times.

THOS. VICKERS, *Secretary.*
Central House, New St., Birmingham.

BOARD OF TRADE ANNOUNCEMENT.

SAFEGUARDING OF INDUSTRIES ACT, PART I.
ARBITRATIONS UNDER SECTION 1 (5).:
ROCHELLE SALT.

The Referee has given his decision in the matter of a complaint under the above Subsection that Rochelle Salt has been improperly included in the Lists of Articles chargeable with duty under Part I. of the Act. The Referee states that there is no evidence that Rochelle Salt is wrongly included in the Lists, and he awards that the complaint fails.

Board of Trade,

22nd August, 1923.

PROTEIN REACTIONS.

(With Special Reference to Egg Albumin).

By R. F. Hunter, F.C.S.

It was considered that the study of the reactions from a purely elementary qualitative point of view, of some of the commoner laboratory reagents with proteins might be a subject for investigation.

5g. of flaked egg albumin were, therefore, dissolved in 200 cc. o fwater as completely as possible. A white suspension was obtained. To portions of this in test tubes various reagents were added as follows:—

Acids:

1.—*Concentrated* H_2SO_4: white semi-transparent flocculent precipitate, coagulating when boiled.

2.—Co. HNO_3: pale yellow solution, precipitate palo yellow—coagulates on boiling.

3.—Co H Ce: Pale white flocculent p p. coagulation on boiling.

4.—H_3PO_4: No pp, nor does warming produce pp.

5.—H_3AsO_4: as for H_3PO_4.

6.—CH_3COO H: No apparent action, no p p on boiling.

7. —C O O H
C O O H Indefinite.

8.—Oleic acid: pale brown: pp. on shaking.

NaO H: white flocculent pp. etc.

NH_4OH.

Br Water: immediate yellow pp., coagulation on boiling.

$FeCl_3$: Pale yellow pp.

CusS O_4: Pale blue pp.

$CuSO_4$ + NaO H, beautiful pale blue flakes.

Ni $(NO_3)_2$: Pale green pp.

Am_2S: boiling, darkens and unpleasant odour.

Na_2S: boiling produces white solid which floats on surface.

P $(CH_3COO)_2$ Pb

K_2 Cr O_4: yellow coagulation on heating.

K Cr_2 O_7: orange pp.

Nitroprussiate of sodium

K C N S

K Mn O_4.

C_2H_5OH: white flocc. pp., etc.

CC_2HH_2O: white flocc. pp., etc.

C_6H_6

C_6H_5N H_2: pale yellow suspension.

$C_6H_5NHNH_2$ red brown pp., red coagulation on boiling.

$C_6H_2(OH)$ $(NO_2)_3$, bright yellow pp. coagulation as such on boiling.

H A_3 indefinite.

The precipitation of some common elements in the presence of egg albumin was now examined.

Method: Suspension or rather dilute solution of salt studied and albumin made with water.

1.—$Pb(NO_3)_2$
HCl added—
pure white precipitate settles into two layers, solution apparently floating on suspended precipitate.

Sulphides:

Hg Cl_2:

Sulphide first pp., orange, then separation into two layers takes place, when we have a black p.p at bottom, and transparent jelly-like suspension above layer of black sulphide.

$CuSO_4$:

Black brown p.p appears above solution, blue-dirty green coagulated p.p appears at bottom of tube.

Bi $(NO_3)_2$:

Sepia precipitate and almost red brown solution. Exp. repeated with dilute solution and 1 bubble of 2S allowed to pass, red brown precipitate appears on the top, a white coagulation at bottom of tube, and between these two a pale brown solution.

$CdCl_2$ - H_2S produces bright yellow homogeneous precipitate filling tube.

As_2O_3: a pale yellow suspension from passage of H_2S and a jelly-like chrome solid floats on layer of liquid. Am_2S added which dissolves p.p. HCl addition produces peculiarly formed plastic yellow p.p. filling tube of S and As_2S_3.

Sb Cl_3 solution, are HCl and albumin solution:

H_2S, beautiful orange red p.p. floats on white-pink solution.

Sn Cl_2, deep brown p.p. floats above, almost pink solution.

Fe_2Cl_6 and AmOH, deep red brown flocculence on top of pale yellow liquid.

Chrome alum and AmOH:

Plastic grey green flocculence on surface of solution.

Am_2S and $MnSO_4$:

Pale pink p.p. above solution.

Am_2S and $ZnSO_4$, yellow colouration on top, below this olive green layer, below this dirty grey and solution below this.

Co $(NO_3)_2$ and NH_4OH:

Blue layer above pink solution, excess AmOH produces sea-green p.p.

It was thought that a solution, or, to be more accurate, a suspension of egg albumin, might exhibit some colourations with sulphuric acid solutions of organic bases Con-

sequently this was attempted, the method being to add a small quantity of the base in its sulphonic acid form in concentrated sulphuric acid to a portion of the albumin solution in a test tube. The results were as follows:—

Phenol.—Indefinite reaction with clearing of suspension.

a-Naphthol.—Yellow solution with p.p. formation.

β-Naphthol.—Brown and cloudy.

Sulphanilic Acid.—Clear and almost golden.

Dimethylaniline.—Pinkish solution and flocculent precipitate.

Salicyclic Acid.—White flocculent p.p.

Resorcinol.—Yellow-green solution and p.p.

Quinol.—Bright golden and yellow p.p. floating.

Pyrogallic Acid. — Pale-grey-pink and clear solution.

Phenolphthalein.—Clear sherry coloured solution.

Fluorescein.—Bulky olive green precipitate.

Eosin.—Red brown bulky p.p.

Alizarin.—Brilliant orange p.p.

Anthracene.—Grey-ochre p.p.

Anthraquinone.—Light grey solution.

Aurin.—Bright chrome solution and similar precipitate.

Malachite Green (leuco).—Golden yellow clear solution.

Benzidine.—Pale violet precipitation floating on similar solution.

a-Naphthyl amine.—Indefinite.

Diazoaminobenzene.—Deep red solution and p.p.

Thiocarbanilide.—Complete white p.p.

m-Nitraniline. — Pale yellow - pinkish tinged p.p.

Quinoline.—Cloudiness.

Pyridine. — Cloudiness and floating of p.p.

The investigation, it will be seen, yielded nothing much worthy of note. The reactions, to put it mildly, are indefinite, which might be anticipated when one considers the complex nature of such a substance as egg albumin, particularly in solution, for in the form it probably contains a fair number of products of hydrolysis, such as complex amino acids, etc. Its effect on the precipitation of metals from their solutions by the usual methods of analyses is nothing remarkable. The only general effect apparently which one can ascribe to it is the tendency which it promotes for separation into layers, viz., the precipitation of zinc as zinc sulphide from its sulphate solution by means of ammonium polysulphide in the presence of albumin. The effect appears to be clearly a colloidal one.

The effect of sulphonic acids of aromatic bases in sulphuric acid solution likewise does not appear to produce much worthy of comment; colour reactions were obtained, as one would expect, but nothing startling was the result.

The effects most interesting were those of coagulation and precipitation of various reagents, the work, as was stated, being qualitative in nature. This effect is not open to deduction. The quantative study of the effect might, however, repay an investigation at a later date, but the qualitative side certainly appears to be of the nature of a failure as far as the present investigation goes.

STUDIES OF IRIDESCENT COLOUR, AND THE STRUCTURE PRODUCING IT.—IRIDESCENT BEETLES.

By Lord Rayleigh, F.R.S.

In this paper the wonderful metallic colouring of certain iridescent scaleless beetles will be considered.

Many previous writers have discussed this subject, and have taken widely divergent views as to the cause of the colours. For a summary, reference may be made to a paper by my father, the late Lord Rayleigh.* As there set forth, the discussion turns mainly on whether the iridescent colour is due to repeated thin plates, as in the case of chlorate crystals, or whether it is of the same kind as the surface reflexion of aniline dyes. The latter view was supported by the authority of Prof. Michelson,† but I understand that he thinks that the last word has not been said on the subject.

In all cases of undoubted surface colour there is a very deep and saturated transmission of colour of complementary tint. When, however, the coloured layer of an iridescent beetle is detached by dissolving away the opaque backing and examined by transmission, it is found not to be deeply coloured, though, of course, it shows some

* "*Phil. Mag.*," vol. 37, p. 98 (1919).
† "*Phil. Mag,*" vol. 21, p. 554 (1911).

colour, as it should do on any theory. This was the argument which, I believe, weighed most with my father, *against* the theory of surface colour, and *for* the theory of interference, or structure colour. He was not able, however, to bring forward any absolutely crucial observation, or argument, and ended by saying: "It must be confessed that much still remains to be effected towards a complete demonstration of the origin of these colours." As in the case of the chlorate crystals, I inherited the specimens which he had procured, and have obtained evidence which, it is hoped, will be found more cogent than any available hitherto. This evidence is in favour of *multiple thin plates*.

The only important publication on the subject which has appeared since my father's paper is one by H. Onslow,‡ in which the whole subject is further reviewed, and many details are given from the biological standpoint about iridescent colours of insects generally, both with and without scales. Onslow accepted the structural origin of the colours in many instances, but for the scaleless beetles here considered he reverted to the theory of surface colour. The argument on which he mainly relied was that the thickness of the colour-producing layer was too small to allow room for the structure of many parallel reflecting planes which would be required on the theory of structure colour. His estimates of the thickness of this layer were made partly in section under the microscope, partly by polishing a flat on the convex coloured surface, so as to remove the colour layer, and examining the way in which the colour fell off inwards along the normal to the boundary of the polished portion. Although I have not attempted to repeat these experiments, and cannot therefore speak from personal experience of the methods, I cannot help thinking, for reasons that will appear, that the results must be misleading.

Happening to examine the specimens in the sunlight with a direct-vision spectroscope, I noticed that in some cases the bright region of the spectrum corresponding to the selective reflexion showed an alternation of dark and bright bands. The phenomenon is often not very conspicuous, the dark bands not being perfectly dark. Again, in some aspects of the insect the dark bands may be much more clearly seen than in other positions. In order to see them with advantage, it is necessary to focus the surface of the insect on the slit of the spectroscope, for otherwise the reflexions from different parts of the surface are superposed. Owing to want of uniformity in structure, the spectra from these different regions are not exactly the same, and a loss of clearness results. I have found it convenient to use a 1-inch microscopic objective to form an enlarged image of the insect on the slit. An ordinary table spectroscope or spectrograph can be used, but the adjustments are much easier with a spectroscope specially designed for use with the microscope. The instrument I have used is of a pattern designed by Sorby, and made by Browning. It was intended for examining absorption spectra of small objects, but serves equally well for the reflexion spectrum. A pointolite lamp is focussed on the specimen by a condenser of 3 inches focus provided with an iris diaphragm. The incident beam may be at about 20° to the axis of the microscope, and the reflected beam at about 10° from the normal to the surface of the insect passes up into the microscope. For preliminary examination the upper part of the spectroscope is removed, leaving the slit opened wide. The field is examined with a magnifier. Any desired portion of the surface is next brought between the jaws of the slit, which is then narrowed, and the spectroscope replaced for examining the reflexion spectrum. For photography, an additional lens and plate holder are added above the direct-vision prism.

Plate 4, fig. 1, shows a spectrum by reflexion from the beetle called *Pelidnota sumptuosa*. The angle of incidence was about 22½°, and the portion of the insect in the field was a strip which runs along the (right) side of the wing case; this coloured strip lay *in* the plane of incidence, and at the angle above mentioned it gave a golden yellow reflexion of great brilliancy.

The position of the insect was adjusted so that the image of this golden band lay along the slit of the spectroscope. For determining wave-lengths the helium lines and green mercury line were put on as a comparison spectrum. It will be seen that the spectrum of the beetle consists of a strong central maximum intensity at about wavelength 6002, bordered on either side by subordinate maxima. The photographed appearance is very similar to the diffraction pattern produced by a rectangular aper-

‡ "*Phil. Trans.*," *B*, vol. 211 (1920).

ture, as when a distant linear source of light is examined through a telescope with a slit limiting the object glass. And although there are, of course, important differences, there is also, according to the view here taken, more than a superficial analogy between the two cases. In the case of the diffraction pattern, the bright centre corresponds to the place in the focal plane when the vibrations from the various elementary strips of the aperture are all in the same phase. If we move away laterally from this position there will be less complete agreement, and a position is eventually reached when the phases range over a complete period, and there will be zero intensity. This corresponds to the first minimum. Beyond this, there will be a certain measure of recovery until a further position, when the phases range over *two* complete periods. This is the second minimum, and so on. All this is repeated on the other side of the centre. In this case the light may be regarded as monochromatic; and, so far as it may not be so, the phenomena are made more complex by chromatic effects.

To pass now to the present case. Suppose that instead of a change of *optical distance* among the component vibrations as we pass away from the centre of the field, we have a *change of wave-length*. This will equally produce a discrepancy among the phases which were originally in agreement, and eventually zero intensity will be reached at the place where the phases range over a complete period. Further on there will be a second minimum, where the phases range over two complete periods.

Now this is exactly what occurs as we pass along the spectrum from the position where the phases of the waves reflected from all the parallel planes are in agreement. To state the matter quantitatively. Let there be n strata. If we neglect the effects of dispersion in the passage of light through the strata, then the whole relative retardation for rays reflected at a given incidence from the extreme planes of the system is a fixed linear quantity, l, independent of the wave-length. If we suppose, further, that the deflexion is of the first order, we have, at the centre of the system, λ_0, when the reflexion is a maximum,

$$l = n\lambda_0$$

at the first minimum on the red side λ_1

$$l = (n-1)\lambda_1,$$

and at the first minimum λ_1 on the violet side

$$l = (n+1)\lambda_{-1}.$$

Similarly for the second minima we have

$$l = (n-2)\lambda_2 \text{ and } l = (n+2)\lambda_{-2}$$

so that the distance in angstroms between the first minima is

$$\left(\frac{1}{n-1} + \frac{1}{n+1}\right)\lambda_0,$$

and between the second minima

$$\left(\frac{2}{n-2} + \frac{2}{n+2}\right)\lambda_0.$$

If n is large, these distances become $\frac{2}{n}\lambda_0$ and $\frac{4}{n}\lambda_0$ respectively. Applying this to the actual case, we find from the measured spectrum that the first minima are at wave-lengths 6215 and 5790; difference 425 A. The second minima are at 6460 and 5592; difference 868 A; sensibly double the distance of the first minima.

Taking the central wave-length as λ 6002, we get

$$n = 34.$$

The observed appearances are therefore explained in detail, not only as regards the central maximum, but also as regards the *lateral subordinate maxima*, by assuming the existence of thirty-four strata, which are situated at distances apart comparable with half wave-length in the chitinous material. This particular reflexion shows a much narrower band in the spectrum than any other I have met with, and it is the only case where the subordinate maxima can be well made out; but these are almost certainly differences of degree. This case requires a much larger number of reflecting planes than most others to explain the more nearly monochromatic character of the reflexion, and they are probably more evenly spaced than usual. Unevenness of spacing would, of course, obliterate the subordinate maxima, just as bad figure in a telescope objective tends to obliterate the diffraction rings round the image of a star.

Bands quite similar to Plate 4, fig. 1, may be observed if a good Lippmann photograph of the spectrum is examined by reflexion in direct sunlight with a pocket spectroscope. The broad central maximum, with the lateral maxima, are quite well seen, just as in the beetle.

The question now arises, can these bands be explained with any degree of plausibility as resulting from surface reflexion? It is certainly by no means impossible to obtain a surface reflexion showing a banded spectrum. Crystals of potassium permangan-

ate give a reflexion showing such bands. These bands, however, are complementary to the bands of the absorption spectrum.* This in itself suggests that their position should be independent of the angle of incidence, and, in fact, I have not been able to observe that their position changed at all when the incidence was varied from nearly normal to about 45°.†

The reflexion bands shown in Plate 4, fig. 1, vary considerably as regards their position in the spectrum. This may be seen from their marked inclination to the lines of the comparison spectrum. As we pass from one part of the insect to another, the bands shift. This may result partly from change of obliquity, but I believe more from change of structure. Neither of these causes would be expected to act if the spectrum were kindred to that shown by potassium permanganate, for, as we have seen, the permanganate bands only shift under extreme variations of incidence, and we cannot well admit a progressive variation in the chemical nature of the reflecting substance itself. To postulate a large number of different chemical substances giving bands in different positions of the spectrum would be to place an intolerable burden on the theory of surface reflexion as the cause of the bands.

Moreover, the broad central band with lateral maxima conforms exactly to the requirements of the theory of multiple reflexion from thin plates. On the other hand, so far as I know, there is no absorption spectrum or surace reflexion spectrum having these features.

When it is permissible to sacrifice the specimen, I have found it convenient to cut a small piece about 1 mm. square, and to mount it on the microscope stage on a special holder, which allows the piece to be rotated in its own plane, and also about an axis which lies in that plane. The specimen can then readily be brought to a position which shows the spectra to advantage.

I have examined in this way, one of the golden beetles, *Callodus parvulus*, which shows a remarkable spectrum of bands (Plate 4, fig. 2). These are most pronounced at the red end of the spectrum, and come out more distinctly when the condenser iris is narrowed to a few millimetres, so as to define more precisely the angle at which the incident rays fall upon the specimen.

If the spectroscope is replaced by an ordinary eye-piece, it can be seen that the bright reflexion from a given small area on the specimen persists when the specimen is rotated over as much as 10° of arc. In this observation the incident pencil was very narrow.

The surface of the insect appears to be divided up into a large number of areas which differ somewhat in structure, each giving a slightly different spectrum from its neighbours. Thus, the spectrum is divided vertically into a number of strips differing from one another as to the exact position of the dark spectral bands. The photograph as reproduced has a vertical magnification of about ninety times. It may be inferred that the areas on the insect have linear dimensions of about 10 μ, and it appears that the wide angular range of reflexion is due to the small size of the optically continuous reflecting areas. The case is in this respect similar to that already encountered in the case of labradorite.* It may be that the absence of a definite polarising angle is explicable in the same way.

The bands in this spectrum are to be accounted for generally in the same way as the bands seen in certain chlorate crystals of complex structure.† It is necessary to postulate a group of planes giving a spectrum band limited to the red region, and

* See Stokes, "Phil. Mag," vol. 6, p. 393 (1853), or "Mathematical and Physical Papers," vol. 4, p. 47.

† *Beyond this point the bands are rather difficult to make out, but as was shown by Stokes, they can be brought into view by polarising the incident light perpendicularly to the plane of incidence. Introducing a nicol to do this, I have observed that at an incidence of 70° there is a slight shift of the bands, amounting to about 80 A. or say one-third of the width of a band as compared with the position of the bands at small incidence, or in the absorption spectrum of the solution. This displacement is towards the violet, in the same direction therefrom as the bands due to interference, but relatively very small in amount. I have only made a few casual observations on the subject. It deserves to be pursued more closely. The existence of the displacement was confirmed by photographing the spectra along with a comparison spectrum.*

* "*Roy. Soc. Proc.*," *A*, vol. 103, p. 34 (1923).

† "*Roy. Soc. Proc.*," *A*, vol. 102, p. 668 (1923).

another group situated at a distance from the former which gives a reflexion extending over the yellow and green. In the red region of the spectrum where these two systems overlap, we get a series of bands resulting from comparatively high interference. The distance from one dark band to the next was measured as 151 A., at wavelengths in the neighbourhood of 6200 A. and for an incidence 11° from the normal. If these bands were regarded as due to the interference of light from two strata only, as in the case of the two surfaces of a single thin film, we should have a relative retardation of forty-one waves.

The incidence may be treated as practically normal, thus the thickness would be 20.5 waves in the chitinous material, or about 8 μ. In the actual case the two interfering beams are regarded as coming not from single surfaces but from two groups each consisting of several planes. The distance between these two groups is the distance calculated above as 8 μ.

This is a much longer distance than the estimate found by Onslow from his polishing experiments on closely allied beetles, which gave him 0.5 μ only for the whole thickness of the layer concerned in producing colour. If his estimate were accepted, the theory of interference for these bands in the spectrum would have to be abandoned.

I cannot think that any one who will examine with a pocket spectroscope the bands produced by reflexion from a piece of mica 1/100 mm. thick will be willing to admit that the bands from *Callodus parvulus*, here reproduced (Plate 4, fig. 2), are essentially different in origin. I think, too, that a comparison of Plate 4, fig. 1 (*Pelidnota sumptuosa*), with the bands seen when a Lippmann film is examined with a small spectroscope in strong sunlight will irresistibly lead to the conclusion that the origin is similar in each case, and that the beetle, like the Lippman film, shows reflexion from numerous planes, uniformly spaced.

SUMMARY.

It is shown that some of the iridescent beetles which have striking metallic colours show band systems in the spectrum of the reflected light. Two such spectra are reproduced.

The first, from *Pelidnota sumptuosa*, shows a central maximum, bordered on either side by subordinate maxima in exactly the way that reflexion from a quite uniformly spaced assemblage of thin plates would require. The number of planes calculated to be required in this case is no less than thirty-four. A Lippmann film shows a similar spectrum.

The second spectrum is from one of the golden beetles, *Callodus parvulus*. The bands are accounted for on the supposition of two assemblages, each consisting of several reflecting planes, the distances between the assemblages being about 8 μ. This would result in a series of equally spaced bands over a limited range of the spectrum, as observed.

The possibility of either of these spectra being produced on the alternative theory of surface reflexion is discussed, and is found to require a number of special suppositions, which seem very difficult of acceptance.

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LABORATORY EXPERIMENTS ON THE EXTRACTION OF MESOTHORIUM FROM MONAZITE SAND.

By HERMAN SCHLUNDT.*

In his paper on the chemistry of mesothorium, Soddy described several experiments on the separation of mesothorium from monazite sand. In one experiment, 800 grams of monazite sand were decomposed by heating with twice its weight of concentrated sulphuric acid to which about 0.1 per cent. of barium carbonate had been added before heating. The product was stirred with cold water, and the muddy liquor obtained was decanted from the unattacked ingredients in the sand. The sediment obtained from the muddy solution contained practically all the mesothorium and radium in the monazite. The sediment from 800 grams of monazite weighed 14.5 grams and contained practically the whole of the material. The unattacked sand retained 8 per cent. of the material. A further precipitation of 1.6 grams of barium sulphate formed in the clear monazite solution possessed a small initial activity, due to regenerated thorium X only, which decayed almost completely in the course of a month. Soddy estimated that less than 5 per cent. of the mesothorium was present in the solution. The presence of thorium X in the precipitate of

* *From a paper on Mesothorium, published by the Department of the Interior, Bureau of Mines, Washington.*

barium sulphate and the absence of mesothorium are regarded as clear evidence that practically the whole of the mesothorium can be separated from monazite by this method. Measurements were made by the gamma-ray method both of the original material and of the sediments. The gamma activity of the main sediment fell to 57 per cent. of its maximum value in the course of a month, as the effect of the decay of thorium X exceeded the increase due to the generation of radium C.

Soddy's procedure for extracting mesothorium was repeated in several experiments with 500 grams of monazite sand containing 6.54 per cent. of thorium oxide. One gram of barium chloride was added to the samples, before heating the sand with twice its weight of concentrated sulphuric acid. Four per cent. of the acid boiled off during cooking. The resulting paste after cooling was stirred up with 8 litres of cold water, and the muddy liquor slimed off. The unattacked sand was stirred up with another litre of water, and this liquor was decanted off and combined with the larger volume, thus making a solution containing about 10 per cent. sulphuric acid. The sediment from this solution had a dry weight of 6.2 grams, the unattacked sand 46.2 grams. In the course of several days the acid liquor gradually gelatinised on account of the partial separation of thorium as phosphate.

As the measuring instruments were not sensitive enough for accurate measurements of the gamma radiation of monazite sand, the recovery of mesothorium and the losses were obtained by making radium determinations in the monazite, the sediment bearing the mesothorium and radium, the unattacked sand, and the liquors. The radium determinations were made by the emanation method. From the sand, the unattacked residue, and the concentrate bearing the mesothorium and radium, the emanation was separated by boiling suitable samples of these materials with concentrated sulphuric acid, collecting the emanation thus liberated quantitatively, and measuring it electroscopically in calibrated air-tight electroscopes.

As the liquors coagulate upon boiling owing to the separation of thorium phosphate, it was necessary, in order to hold the thorium in solution, to acidify the liquors more; for this purpose concentrated hydrochloric acid was used. The emanation could then be separated quantitatively by boiling, as in the quantitative determination of radium emanation present in natural waters.

The radium content of the sample of monazite sand used, containing 6.54 per cent. thorium oxide, was found to be 7.98×10^{-10} grams per gram when the determinations were made by decomposing the sand with concentrate sulphuric acid, and 8.21×10^{-10} grains when the radium determinations were made by fusion of the finely ground samples to which a little barium salt had been added with mixed alkali carbonates followed by estimation of radium directly in the refined barium sulphate.

The radium retained in the unattacked sands was to be 6.5 per cent. by the sulphuric acid method, and 7.4 per cent. by the method involving fusion with mixed carbonates of sodium and potassium. These results confirm the loss of about 8 per cent. reported by Soddy.

In the liquors were found 5.6 per cent. of the radium, making a total loss of about 12 per cent. In the radium-mesothorium bearing concentrate, 84 per cent. of the radium in the ore charge was recovered, leaving 4 per cent. unaccounted for.

PLANT EXPERIMENTS ON THE EXTRACTION OF MESOTHORIUM FROM BRAZILIAN MONAZITE.

No experiments were conducted on a plant scale to ascertain whether corresponding recoveries of mesothorium could be duplicated. As already stated, in the plant runs the mesothorium-bearing concentrate was separated at a later stage of operation. The intermediate stages include several treatments where rather large volumes of liquor are decanted off, therefore it is not surprising that the recovery of mesothorium falls to 65 per cent. as a result of mechanical losses of barium sulphate in these operations. The successive treatments of crude thorium phosphate eliminate nearly all of the phosphoric acid, and when the thorium chloride solution is finally obtained, a black slimy residue remains which bears the active barium sulphate.

After the residue had been washed twice with water by decantation, it was transferred to a stoneware suction filter and given another washing or two with hot water. Before analytical work on it was begun, the residue was dried for several days in steam kettles or on hot plates. At this stage the residue consisted of small, greyish-black lumps having the texture of

rather low-grade graphite. This product was then pulverised to pass through a 20-mesh sieve by means of a disc pulveriser, after which it was carefully composited by quartering. The product is termed in this paper the crude concentrate of mesothorium. Duplicate samples of 500 grams each were set aside for analytical determinations of barium, lead, and radium, and for gamma-ray measurements. These samples also served in part for the laboratory experiments on the preparation of refined concentrates, which are described in a later section.

From the data summarised in Table 7, it was concluded that the addition of 1 pound of barium chloride to 400 pounds of ore, instead of 1 to 200 pounds, does not reduce the percentage recovery of mesothorium in the crude concentrate. In later runs, it was found that the addition of one-fifth of 1 per cent. of barium chloride crystals to the ore charge was sufficient to protect the mesothorium. The crude concentrate obtained when the smaller amount of barium was added, generally contained a little more than 1 milligram of gamma-ray activity per kilogram of weight.

The factor for the conversion of pure barium chloride, $BaCl_2\ 2H_2O$ into barium sulphate is 0.955. In the first plant run, the crystals of barium chloride added gave 1.15 per cent. of their weight of barium sulphate. In the second run, the factor was 0.9376. These factors were used in calculating the quantities of barium sulphate that resulted from the quantities of chloride added in the respective runs.

A complete analysis of the crude concentrates was not attempted. The analytical data obtained clearly show that the concentrates are complex mixtures, and in comparison with the "First sulphates" of radium-barium separated in the recovery of radium from carnotite ores, they are of low grade in barium content. By qualitative tests it was found that the crude concentrates were practically free from silica, but that 1 to 2 per cent. of phosphoric acid was still present. A small amount of thorium was also retained; lead was also present—some of it soluble and some insoluble in water. The source of the graphite and amorphous carbon present Mr. Gulbrandsen traced to the iron pots in which the sand was cooked with sulphuric acid. In the early plant runs the quantity of carbon present in the crude concentrate was more than was required to reduce the barium sulphate to sulphide. Some lead chloride could be extracted from the concentrate by digestion with hot water. By far the larger proportion of the lead was present as sulphate. Its amount varied considerably in different concentrates. From the concentrate obtained in plant run No. 2, nearly 5 per cent. of lead chloride was extracted by successive treatments with hot water. After the removal of the lead chloride from this concentrate, a determination of lead showed that an additional 15 per cent. of lead sulphate remained in the concentrate. The percentage of barium sulphate present in four different lots of concentrate analysed ranged from 52 per cent. in run No. 1 to 37 per cent. in one of the later plant runs.

By making radium determinations on composites of the different wash liquors, it was found that the radium losses in the acid solutions amounted to 34.6 per cent. in run No. 1 and only 20.2 per cent. in run No. 2. No explanation for this marked difference was evident. The losses in the alkaline liquors were relatively low—5.7 per cent. in No. 1 and 4.5 per cent. in No. 2.

(To be continued.)

EMPIRE CANCER CAMPAIGN.

Appeal for Voluntary Workers—Bereaved Father's Suggestion.

The British Red Cross Society, which is organising the appeal for the British Empire Cancer Campaign (which aims at raising £1,000,000 for Cancer Research) is appealing for voluntary workers who will assist in the collection of funds.

From the Headquarters of the Society, 19, Berkeley Street, W.1, pamphlets and leaflets advertising the aims of the campaign, books of sixpenny and shilling stamps to be sold for the benefit of the campaign, and posters designed for the purpose of advertising local fetes, concerts, etc., held in the interests of the campaign may now be obtained on application. Local organisers willing to assist the campaign may also obtain literature, stamps and posters through the medium of the local branch of the British Red Cross Society.

A valuable suggestion has been made by Mr. Reuben Wood, of Sheffield, who recently suffered the loss of his son through cancer. Mr. Wood, reading the appeal issued in May by the promoters of the

British Empire Cancer Campaign, at once wrote to the headquarters of the campaign, expressing his wish to make a collection on its behalf as a tribute to the memory of his son. He was then put into touch with the local director of the British Red Cross Society, and with the help of the local organisation was able to collect £38 9s. amongst his friends within three weeks.

Mr. Wood, who is helping to increase this sum to £100, makes the suggestion that all who have suffered a bereavement through cancer should follow his example and take active part in helping the work of the crusade which has been formed to fight the most terrible of all diseases.

When it is realised that cancer was responsible in 1921 for the loss of more than 45,000 valuable lives, and that this most cruel of all plagues is taking a steadily increasing toll of life, it is hoped that the example set by Mr. Wood will be followed in every town and village in the United Kingdom, until the sum of £1,000,000 is realised as the national contribution to the fighting fund which is to stand between the community and the advance of this disease.

NOTICES OF BOOKS.

The Structure of the Atom, by E. N. DA C. ANDRADE, D.Sc. (London), PH.D. (Heidelberg). Pp. XIV. + 314. London: Messrs. Bell & Sons, Ltd., York House, Portugal Street, W.C.2. 1923. 16s. net.

Interest in scientific matters is not diminished by sharp conflicts in theory, for well-established ideas when in fundamental opposition stimulate interest and speculation; and one is always keenly interested in watching the developments in such cases. It is natural to expect that the true or more complete theory will remove the features in conflict and co-ordinate the otherwise discordant data.

At the present time, as is well known, two theories hold the field in respect of the atom; one being the *dynamic theory* so beautifully developed by N. Bohr, A. Sommerfeld, and others; the other being the *static theory* due largely to G. N. Lewis, W. Kossel and I. Langmuir.

Before the above theories were developed it was known that some radio-active atoms emitted β particles, which are negative electrons, at velocities almost that of the propagation of radiation in free space. This fact speaks strongly in favour of a dynamic atom, for how could these electrons acquire such a prodigious velocity if they were not circulating in practically closed orbits within the domain of the atom? It is true that α particles, helium nuclei (He^{++}) are also emitted in one case with a velocity as high as about 12,800 miles a second, and it has not been suggested that they describe orbits within the atom; but enormous forces, relative to the masses involved, must exist in connection with the nucleus of the atom to give effect to such velocities, as radio-active phenomena indicate.

The energy represented by the emission of fast-moving α particles in the process of radio-active disintegration is greater than that of the fast-moving electrons similarly ejected, for the mass of the former is over 7,000 times greater than that of the electron. From the energy point of view, therefore, the argument supports what might be termed the tension or strain idea as against the circulation idea, but in either case enormous forces relative to the size or mass of the bodies ejected must exist.

The smallness of the electron in terms of mass, however, leads one to expect it to suffer a great activity, for we know from the kinetic theory of gases and the Brownian movement that the great concentrated energy involved demands anything but a quiescent state of affairs. One is led to believe, therefore, that the electron has an orbital activity. If it has not such an activity, then there are conditions obtaining in the atom which make it possible to store energy by tensions or strains which are exceedingly great; but the researches of Sir E. Rutherford and the studies of Bohr point so conclusively to intra-atomic spaces in which fast-revolving electrons comport themselves, that the orbit theory is the only natural one that seems possible. As is well known, Bohr has, by applying the quantum theory to the dynamics of the atom in respect of its electrons, succeeded in accounting for the emission line spectra of hydrogen and ionised helium in a most remarkable and convincing way. This theory is in such perfect accord with the quantum theory which has now a wide application in respect of all atomic radiations, including the so-called resonance radiation that there is here something which can hardly be due to any form of coincidence or a chance character.

The orbit theory receives strong support from the investigations of Sommerfeld, for he has shown that the application of rela-

tivity to the fast-moving electrons describing elliptical orbits accounts for the fine lines observed in the spectra of hydrogen and ionised helium; and, moreover, that the principles developed by this relativity analysis can be extended to the movements of electrons in atoms of the heavy elements. In this case the L doublet observed with X-ray spectra is quantitatively accounted for by the application of relativity to electrons describing Keplerian orbits, as in the case of the hydrogen atom.

In addition to the above, the Zeeman effect and the Stark effect have been brought into line with the dynamic type of atom established by Bohr.

The evidence seems overwhelmingly in favour of electrons describing orbits round the nuclear parts of atoms, especially those which give rise to the spectrum lines, but the static octet theory developed by Lewis and Langmuir accounts for such a mass of chemical and chemico-physical data, valency phenomena in particular, that it balances in fact the mass of data co-ordinated by the dynamic theory, as already stated.

The problem is to reconcile these two most remarkable theories without destroying the essential features of either one.

Those interested in this problem will find Prof. Andrade's book worth careful study, as the subject of atomic structure is adequately treated therein. In his concluding remarks he says: "Something as to the possibility of a reconciliation between dynamical and statistical models will be expected in such a book as this, and a word on the subject will be attempted. Have we here the complete contradiction which remains a mystery for wise men and weaker brother alike?

'Denn ein vollkommner Widerspruch,
Bleibt gleich geheimnisvoll für Kluge wie
für Toren.'

The answer is that we have to consider not whether an electron can be at rest and in motion at the same time—I am not sufficient of a philosopher to attempt an answer to that question—but rather whether it follows that, because for certain problems electrons may be conveniently treated as if they were at rest, they cannot be in motion? In my opinion, by no means. In the very eccentric orbits of Bohr's theory, for which the azimuthal quantum number is 1, the electron visits the outer parts of the atom periodically, and must have a preponderating effect on an electron of another atom at the same time when it is furthest from its own nucleus. Thus the external loop, if I may so call it, of such an orbit may well correspond closely in its chemical effect to an electron stationary somewhere in the region of, say, the empty focus of the ellipse to which the loop is known to approximate in form. Although the electron visits the nucleus periodically this part of the orbit which is distant from the nucleus behaves as if of different quantum number to the inner part, and as if the nucleus had an effective charge different from the actual charge, as has been pointed out in Chapter XI. Hence it is not improbable that this part of the orbit may act in a special way, much like the stationary electron or localised orbit demanded by the followers of Lewis. These loops appear locally in the surface of the atom, and may be likened—to commit myself to a picture for whose crudeness apologies are due—to handles on a spherical jug. It is true that there is a slow motion of the aphelion—or apnucleon—of the orbit, but this will have no essential effect on the problem under consideration. The nature of the forces which exist between the loops of different atoms may be electrostatic or magnetic—we need not here offer an opinion. We are more justified in considering the loops as if they were actual attachments to the atom, in that Bohr often speaks of his orbits rather as if they were actual pipes or conduits than as if they were mere paths traced out by an electron. I do not mean for a moment to suggest that this is more than a method of drawing attention to the supreme importance of the form of the orbit." To continue—

"We can also, of course, consider an electron to be shared without it necessarily being at rest. It seems, on general grounds—which are admittedly often deceptive—quite possible that one electron may pass from the orbit of one atom to an orbit of another atom, describing either a figure of 8 orbit, including a nucleus in each loop, or an approximately elliptical orbit of larger dimensions, including two nuclei within it. A conception of electron-sharing may be reconciled with a dynamical atom."

Referring to Meitner's model for radioactive nuclei, page 116, we think that the statements in this connection could be made clearer to advantage.

Bauxite is an ore of great importance in certain industries. For example, when it is fused in a special electric furnace, crystals of aluminium oxide are formed which are extremely hard, the diamond being only slightly harder. This is known under the registered trade name as Alundum. Alundum, besides being used for the well-known abrasive wheels for grinding and finishing materials in the course of manufacture, is used in another form for stair treads, as for example on tramway cars, or in railway stations. It is used also for danger places in factories where slipping must be prevented. It is quite acid resisting, and can be used in chemical works' floors. Clay is used as a binder to form the alundum tiles, wheels, etc.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

20385—Gaillard, E. A.—Manufacture of sulphuric acid. Aug, 10.

20132—Jucker & Co., Chemischo Fabrik.—Recovering chromic salts from residues. Aug. 7.

Specifications Published this Week.

201231—Merrill Co.—Process of precipitating metals from solutions.

201302—Farbwerke vorm. Meister, Lucius & Bruning.—Manufacture of a complex amino-argentomercaptobenzene-carboxylic acid.

185728—*Etablissements Poulenc Freres.—Process* for the commercial preparation of amino-phenyl-arsenic acids and of their derivatives.

201488—Vains, A. R. D.—Continuous chlorination of ligno and pectro-cellulose by nascent chlorine for the purpose of obtaining *pure cellulose.*

197932—Pereira, H.—Process for manufacturing a dye from dioxyperylene.

Abstract Published this Week.

199154—Isatine arylides, Stephan C., of Altona, Germany.

Isatine-...-arylides are isolated from their solutions in sulphuric acid as sulphurous acid compounds by treatment with ammonium sulphite or bisulphite in quantity corresponding with the whole sulphuric acid content; preferably the sulphuric acid solution is introduced into the *sulphite solution in the form of a spray.* Ammonium sulphate is recovered as a bye-product, and the escaping sulphur dioxide is absorbed in ammonia to produce sulphite again. Examples are given in which the reaction product (containing isatine anilide) of example III. of Specification 15497/99 is allowed to react with solutions of *ammonium sulphite* or bisulphite, the isatine anilide sulphurous acid compound being precipitated.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

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THE CHEMICAL NEWS,

VOL. CXXVII. No. 3308.

THE QUANTUM THEORY.

By R. F. Hunter, F.C.S.

In a recent lecture delivered before the Chemical Society of the Royal College of Science, entitled: "Some Aspects of the Quantum Theory," Dr. C. K. Ingold, D.Sc., F.I.C., remarked that the quantum theory is less an attempt to explain than a focussing of all difficulties into one. This is very true, and it might be of some interest to us as chemists to consider, firstly, the nature of the quantum theory, and, secondly, its application in Chemistry; for the theory, though now regarded as a destined branch of Physical Chemistry, or rather Chemical Physics, is one of considerable importance to us as chemists, mainly because of its close connection, or rather interdependence with the Bohr theory of the atom, and we fear has been too long regarded in the light of a piece of mathematical physics, and its application in chemistry as being almost of the nature of trespassing of chemists in a field which is one of the most sacred domains of mathematical physics, almost as sacred as that of the theory of relativity. There would appear, therefore, no necessity to apologise for a brief elementary, and, as far as can be non-mathematical review such as this, in a chemical journal. It will of course first be necessary to run over briefly in a rough way, some of the considerations of mathematical physics, such as the question of statistical mechanics.

Entropy & Thermodynamic Probability, Etc.

If we have Na molecules of hydrogen in a given space v and Np of oxygen in a space v

Then it can be shown that if we require 2 molecules of hydrogen to combine with one of oxygen, the chance of this occurrence is given by the expression:

$$\left(\frac{Na}{Na + Np}\right)^2 \quad \frac{Np}{Na + Np}$$

and the rate of collision will obviously be given by an expression:

R = Rate of Collision = $K. C_a^2\ Cp$,

where R is a constant and C_a and Cp the concentrations.

The above is a simple application of the laws of mathematical probability to the kinetic theory of gases.

We next consider the question of entropy and thermodynamic probability, and the relation can be shown to be of form

Entropy $\propto \log_e$ (Probability)

or $S = k. \log_e W.$

to be more general

$$S = k \log_e W + \text{constant}.$$

By means of Boltzmann's expression,

$$S = k N \log. u + k N \log. v + k.$$

where U is internal energy of our system.

R being defined as above;

N = Number of molecules in system being a constant.

We can arrive at

$$\frac{\delta S}{\delta T} = \frac{1}{T}\,\frac{\delta U}{\delta T},\quad \frac{\delta S}{\delta T} = \frac{3}{2}.\,k\,N.\,\frac{1}{U}.\frac{\delta U}{\delta T}$$

$$\text{hence}\quad U = \frac{3}{2}\,k\,N.T.$$

But we know that the total kinetic energy of molecules of a gm molecule to be

$$\frac{3}{2}\,R\,T \text{ in case of monoatomic gas}$$

$$\text{then}\quad U = \frac{3}{2}\,R.T.$$

and we arrive at N.K. = R.

where R is gas constant per molecule, and for a perfect gas $\frac{3}{2}$ R = Cv. Cv being gn molecular heat at constant volume, and hence our equation for monoatomic gas becomes

$$S = Cv. \log T + R \log v + K$$

S = entropy of a gm molecule.

We now come to the question of equipartition of energy:

We consider a molecule of gas to have, firstly, energy of translation; secondly, energy of vibrations; and thirdly, energy of rotation. The molecular rotations being ascribed to collisions with other molecules, and quite distinguished from atomic vibrations. Instead of molecular rotation we might have precessional vibrations. Now, in the case of diatomic molecules, we have three degrees of freedom due to translation, one in respect to linear, and two in respect to molecular rotation: six in all.

Regarding rotation as impossible and substituting precessional vibrations corresponding to degrees of freedom, again we have six in all. Now

$$\frac{1}{3} Mu^2 = R T = \frac{1}{3} N. mu^2$$

$$\text{KE of gm. mol.} = \frac{3}{2} R T.$$

Hence, since gas molecule has three degrees of freedom in virtue of translation, applying equipartition principle, we obtain each degree of freedom possesses

$$KE = \frac{1}{2} RT.$$

It can be shown by application of elementary mechanics that the potential energy of a particle in circular vibration is equal to the KE of vibration.

Hence we arrive at the conclusion that for a diatomic molecule, provided the law *of equipartition holds, and provided that all* degrees of freedom are equally effective:

$$\text{The total energy} = \frac{7}{2} RT.$$

Also R = 2 cals ap.
Therefore Energy = 7 cals.

But the molecular heat of diatomic gas varies with temperature in a way unaccounted for by equipartition principle

Where $\frac{Cp}{Cv} = Y$ Then of n = No. of degrees of freedom of the Gas molecule

$$Y = 1 + \frac{2}{n}$$

and in a diatomic gas $Y = 1.4 \therefore n = 5$
$Y = 1.3 \therefore n = 7$

and further Y is not constant and varies with temperature.

The atomic heat of solids theoretically can be shown to be given by $Cv = \frac{d}{dT}(3\ RT)$ = 3 R on the equipartition principle.

This means that the atomic heat of a monoatomic solid should be constant and independent of temperature; but we know that atomic heat of elements in a solid state is a function of temperature, and further that this, the atomic heat, is a continuous function of temperature. Clearly then, we are faced with a wide discrepancy between what is theoretical and what we know from our experimental laboratory work.

We now turn from this subject to that of **Radiation.**

Jeans, assuming the number of degr of freedom possessed by the ether to be finite, applying the principle of equipa tion, showed the energy distributed itself the normal spectrum in such a manner tl the intensity corresponding to a region l between, say, $\lambda \ \&\ \lambda + d\lambda \ \alpha \ \frac{\theta}{\lambda^4}$ meaning that we should expect the ener in the spectrum to confine itself nearly e tirely to the ultra-violet region, and this far from being the case, as shown by ph sical measurement.

Previously it had been shown by phy cists that the intensity of radiant ener from a black body *in equilibrium with* t body shows a maximum value for infra-r waves.

Raleigh's experimental work, in whi we have

$$4 \pi k T \lambda^{-4} d \lambda$$

yields a curve with *no* maximum, but ris rapidly as λ decreases.

The integration of the Raleigh-Jean equ tion between the limits λ_0 and $\lambda\ \infty$ *gives us*

$$\frac{4}{4}\ \frac{RT}{\lambda_0^3}$$

This would lead us to consider that ⅛ o the total energy will be for wave lengt $>^2\lambda_0$ and ⅞ between Lts. of $2\lambda_0$ & λ_∞. Hen we should conclude that the number of de grees of freedom of ether is not by an means infinite, and is insufficient to yiel an expression which would involve concep tion of equipartition principle, which wou agree with experimental results.

To clear matters at this point, Plank pu forward his quantum hypothesis of quanta disregarding entirely the equipartition prin ciple. He assumed that changes of energ between matter and ether cannot be con tinuous, but must take place in definit steps which *are multiples* of some smal energy unit, the energy considered being *finite function of the vibration frequenc* concerned.

It is of interest to note at this point that Sir J. J. Thomson considered radiant energy units or "quantum" as a region of periodic disturbance travelling along a Faraday tube.

Plank laid stress on mode of absorption and of emission of radiant energy by mat ter. The energy radiated by one element of a black body, for instance, is partially *absorbed by the elements.* ***Each of these*** **vibrators or resonators which constitute**

material elements in question can only emit or absorb energy in certain fractions.

Plank's resonators in the infra red, we regard as charged atoms; those in the ultra violet as electrons. For the purpose of theoretical considerations Plank regards his resonator as linear, and considers only energy vibration in one direction, entailing one degree of freedom. The important point of Plank's hypothesis is that it does away with the use of the principles of equipartition of energy, and we can state his hypothesis as follows. It is necessary for the energy to attain a finite value e in order that the resonators composing the material system may be able to absorb or emit it.

Essentially, "quantum" is not a fixed and constant quantity of energy, it is, according to Plank, a function of vibration frequency, and we can express his view as the magnitude of quantum = hv, where v is vibrational frequency, and h is Plank's universal constant; and further, if one considers a material system made up of molecules, atoms and electrons, such a system must possess resonators of different dimensions, and hence o difference frequency.

If we consider a system of vibrators and resonators N, and if M possess zero energy, it can be shown that we have a relation:

$$N = \frac{M}{(1 - e^{\epsilon/kt})}$$

If ΣU is total energy of N resonators, we get:

$$\Sigma U = \frac{N\epsilon}{e^{\epsilon/kt} - 1} = \frac{Nhv}{e^{hv/kt} - 1}$$

and if radiation density is u_v:

$$\overline{U} = \frac{c^3 \quad u_v}{8\pi v^2} \qquad (a)$$

$$\text{and: } u_v\, dv = \frac{8\pi k v^3}{c^3} \cdot \frac{1}{e^{hv/kt} - 1} \cdot dv.$$

This is a form of Plank's radiation formula.

If space density of energy be E, and

$$\frac{\Delta E}{\Delta \lambda} = E\lambda$$

it can be shown that

$$E\lambda = \frac{8\pi ch}{\lambda^5} \cdot \frac{1}{e^{ch/\lambda kt} - 1} \qquad (\beta)$$

which is the usual form of Plank's formula for distribution of energy in spectrum.

The meaning of the constant k is shown by consideration of high temperature vibration, where one has the relation

$$E\lambda = 8\pi k T \lambda^{-4}.$$

The above is the account of quantrum theory as it was first conceived by Plank. Plank modified it later as follows:

While emission of radiant energy is discontinuous, viz., taking place in quanta, absorption can take place continuously, this consideration giving rise to a new expression of the form:

$$\overline{U} = \frac{hv}{2} \left(\frac{e^{hv/kt} + 1}{e^{hv/kt} - 1} \right)$$

This brings us to Einstein's work on the calculation of specific heats of crystalline solids, and which is mainly an extension of the quantum theory.

Defining specific heat at constant volume

$$Cv = \frac{dU}{dT}$$

when U and T have usual meanings.

Consider metals, the vibrational energy of atoms about their C.G.S. (three dimensions) is to be regarded as representing the whole internal energy of the atom, and we arrive at relation:

$$3\,R = 6 \text{ Cal.},$$

which is approximate, and which on equipartition principle should be constant, but which we know to vary with temperature.

Using the expression

$$\overline{U} = \frac{hv}{e^{hv/kt} - 1}$$

and denoting the average vibrational energy per gn molecule as U, one arrives at

$$U = \frac{3Nhv}{e^{hv/kt} - 1}$$

$$\text{Put } \frac{h}{k} = \beta o$$

$$\text{Then } k = \frac{R}{N}$$

$$hv = \frac{R}{N} \beta o v$$

$$U = 3R. \frac{\beta o v}{e^{\beta o v/t} - 1}$$

$$\& \ Cv = \left(\frac{du}{dT}\right)_v = 3R \frac{e^{\beta_o v/t} \left(\frac{\beta_o v}{T}\right)^2}{(e^{\beta_o v/T} - 1)^2}$$

The correction giving us Cv as a function of temperature.

(To be concluded next week.)

A THEORY OF CHEMICAL REACTION AND REACTIVITY.

By E. C. C. Baly, C.B.E., F.R.S.

All theories of the absorption of energy by molecules, more particularly the modern radiation theories of chemical reaction, are based on the assumption that molecules are characterised by definite free periods of vibration. Further, the energy quantum theory has as its basis the additional assumption that the absorption and radiation of energy at the molecular frequencies are not continuous but discontinuous. It is a necessary *sequitur* that any radiation theory of chemical reaction developed from these two initial assumptions must be one of monochromatic radiation. It was first shown by Henri and Wurmser, and more conclusively by Langmuir, that all these theories entirely fail to explain the facts. the number of molecules that react being enormously greater than that calculated from the known amount of energy absorbed, and the resulting criticism of these monochromatic radiation theories becomes singularly cogent.

It is well known that any substance (other than black bodies) possesses the power of selectively radiating and absorbing radiant energy of definite frequencies in the infra-red, ultra-violet, and sometimes in the visible, regions of the spectrum. Moreover, the frequencies exhibited by any substance in the visible and ultra-violet are always exact integral multiples of a fundamental frequency exhibited by that substance in the short wave infra-red. Again, the fundamental short wave infra-red frequency is always an exact integral multiple of the frequencies exhibited by the substance in the long wave infra-red. This integral relationship has a most important bearing on the radiation of the energy that has been absorbed. It is obvious if a substance absorbs energy without undergoing any photo-chemical change that the whole of the energy is radiated at longer frequencies. Let is be supposed that a single molecule absorbs one quantum of energy at one of its characteristic frequencies, say in the ultra-violet, without undergoing any photochemical change. This amount of energy is radiated at the infra-red frequencies and indeed as an exact number of quanta at those frequencies. This is only rendered possible by the integral relationship between the frequencies exhibited by the molecule. The monochromatic radiation theories of chemical reaction take n account of the radiation of the energy du ing the reaction.

It is possible to formulate a theory c absorption of energy which is based on as sumptions that are different from thos which are usually made. It may be as sumed first that an elementary atom i characterised not by a free period of vibra tion but by a definite amount of energ associated with a specific physical chang in the atom, such, for instance, as the shi of an electron from one orbit to another. O this assumption an atom can only gain c lose energy in terms of this unit or element ary atomic quantum of energy. A secon assumption may be made that the physic change in the atom occupies a definit period of time which is the same for a atoms. The atom then becomes capable c absorbing or radiating energy of a definit frequency. It may in the third place b assumed that the elementary quanta of a the known atoms are integral multiples of fundamental unit which very possibly is th elementary quantum of the hydrogen aton

On the basis of these three assumption it is possible to formulate a theory c chemical reaction which has very materi advantages over the better known mon chromatic theories. In the first place th theory is not monochromatic and is able t explain the serious discrepancies noted b Henri and Wurmser and by Langmuir. I the second place it appears capable of e plaining the phenomena of absorption spe tra, together with the integral relationshi referred to above. Lastly it seems to pr sent an interpretation of the mechanism a reaction including the phenomenon c catalysis.

When two elementary atoms combine tc gether energy is evolved and the simple possible condition may be assumed, namel that each of the two atoms contributes a equal share of the total energy lost. On th first assumption made above each atom ca only lose energy in terms of its elementar quantum, and therefore the smalles amount of energy that each of the tw atoms can lose is the least common integr multiple of the elementary quanta of th two. Thus, if 3.7 and 7.1 represent th elementary quanta of the two atoms, tl smallest equal amounts of energy that ca be evolved by the two atoms will be 7 quanta of the size 3.7 in the one case, an 37 quanta of the size 7.1 in the other. Th total energy lost therefore will be 2 × 7

$\times$ 3.7 = 525.4. It must be noted that this is only possible on the third assumption of the integral relationship between all elementary atomic quanta.

Further, the gain or loss of energy by the resulting molecule as a whole must be a process in which its atoms bear an equal share, and thus the smallest possible amount of energy that the above molecule can lose as a whole will be represented by the number 525.4. We arrive, therefore, at the conception of a molecular quantum, which is a multiple of the least common integral multiple of the elementary quanta of its component atoms. Just as an atom is characterised by a frequency which is established by its elementary quantum, so also will a compound molecule be characterised by a frequency established by its molecular quantum. It must be noted that molecular quantum is not strictly speaking, a physical entity, but only a summation of an integral number of atomic quanta. Any criticism that might be uttered against the conception of a molecular quantum as the summation of an integral number of atomic quanta, must give way before the necessity on the Planck theory of the radiation of a single quantum, absorbed by a molecule, as an integral number of smaller quanta.

Chemical reaction between atoms, therefore, consists in the joint loss of an equal amount of energy by the atoms whereby a stable molecule is produced. A very essential feature of this theory is that the atoms on combining together do not lose their individuality as absorbers or radiators of energy. The molecule will be able to absorb its molecular quantum and also quanta characteristic of each of its component atoms, and it is important to note that if the molecule specified above be exposed to radiation equal to that of one of its atoms, for example the atom with quantum of size 3.7, this atom will absorb its quanta, and when 142 of these have been absorbed the whole molecule will have gained an amount of energy equal to one molecular quantum.

For the sake of simplicity the case was considered of two atoms combining to form a binary molecule. The same argument applies to more complex molecules, but in such cases the results are not necessarily so simple. Although the molecular quantum is always a multiple of the least common integral multiple of all the atomic quanta, and although the molecule will on examination exhibit its molecular and atomic frequencies, the possibility now arises of definite groups of atoms within the molecule playing their part. In this case, in addition to the molecular and atomic quanta and frequencies, there will be intra-molecular quanta and frequencies characteristic of the atomic groups. Absorption spectra observations have established the existence of all three types of frequencies, molecular, intra-molecular, and atomic, and moreover the combinations of these frequencies due to the simultaneous absorption of two or more quanta have been recognised. It is to these combined frequencies that the breadth of the so-called absorption bands is due.

The molecular frequency is usually situated in the short-wave infra-red, namely, that region lying between the wave-lengths 10μ and 3μ. The atomic frequencies lie in the very extreme infra-red, and are of the order of 1.5×10^{11}, which corresponds to a wave-length of 2000μ, whilst the intra-molecular frequencies lie in the region between the two. In view of the derivation of the molecular frequency it is not necessary to explain the fact that this is always an exact multiple of the smaller frequencies exhibited by the same molecule.

Up to the present nothing has been said of the origin of chemical combination, that is to say the force or affinity which attracts the atoms together in the first place. There is little doubt that the explanation of this is to be found in the electromagnetic force fields of the atom. Each atom forms the centre of an electromagnetic force field and possesses two faces which may be called positive and negative. When two atoms approach one another in such a way that their like faces come together, they will repel one another, but if their unlike faces come together they will attract one another. When two atoms attract one another in this way they are able to lose energy in common as already described, and we call the process chemical combination.

It must be remembered, however, that one face only of each atom is concerned in the chemical combination, and there remains to be considered its second or what may now be called its external face. Since the external faces of the atoms in a molecule must be of different type, it is not possible to assume that they have no influence on one another. The lines of force must condense together to form a molecular force field with the escape of energy. This process obviously is one in which the mole-

cule as a whole takes part, and therefore the energy lost must be in terms of the molecular quantum. The force field condensation therefore will take place in stages, each stage corresponding to the loss of one molecular quantum. A freshly synthesised molecular is unstable, and must lose one or more quanta by the condensation of its atomic force fields, and so must pass into one of a number of possible phases, each consecutive phase differing in energy content by one molecular quantum. It is readily shown that when the freshly synthesised molecule loses one molecular quantum it becomes endowed with a quantum which is twice the molecular quantum, and hence with a frequency which is twice the molecular frequency. In general the phase quantum and phase frequency are $x+1$ times the molecular quantum and frequency respectively, where x is the number of molecular quanta lost in the force field condensation.

In addition, therefore, to its molecular frequency and smaller frequencies due to the atoms and groups of atoms, a molecule will exhibit a phase frequency which always lies in the visible or ultra-violet. Since this phase frequency is an integral multiple of the molecular frequency the whole of the arithmetic relations that have been proved to exist between the frequencies of a molecule are explained. Emphasis may again be laid on these relations. The phase quantum and molecular quantum are not real entities, but only summations of an integral number of atomic quanta. If a molecule absorbs one phase quantum this may be radiated either as one quantum of a less condensed phase together with an integral number of molecular or atomic quanta, which is the origin of fluorescence or phosphorescence, or entirely as an integral number of molecular or atomic quanta. Conversely a molecule may gain one or more molecular quanta on exposure to radiation of a frequency equal to one of its atomic or intra-molecular frequencies.

The moleculur phases may now be considered in greater detail. The particular phase into which a freshly synthesised molecule will pass depends on two factors. In the first place it will depend on the relation between the external fields of its atoms, and in the second place it will depend on the conditions under which the molecule exists. It is evident that if the positive and negative affinities of the external atomic fields are equal and opposite, the molecular force field condensation will proceed far with the escape of many molecular quanta. In such a case the phase formed will be characterised by a highly condensed field with its frequency situated in the extreme ultraviolet. On the other hand if the atomic fields are unequally balanced, the condensation will not proceed very far, and a balance of one type of affinity will remain uncompensated.

When large numbers of molecules are considered it must not be expected that they will all exist in one particular phase. Indeed observation shows that the most usual condition is an equilibrium between two or more phases.

Then again, it follows that it is possible to change the phase in which a molecule exists by supplying to it or taking from it one or more molecular quanta. One of the methods of doing this is by the use of a suitable solvent. The change in frequency exhibited by a molecnle in the visible or ultraviolet by the use of different solvents has been observed in a great number of instances. Similar phase changes have been observed in many cases with change of temperature.

Since the chemical reactivity of atoms is a function of their force fields, so also does the reactivity of a molecule depend on its force field. From what has already been said of the formation of molecular phases it follows that the reactivities of the different phases of a given molecule will be different. The difference in the reactivity of the phases can very easily be proved.

In order, therefore, that a molecule can enter into a particular reaction it is necessary to bring it into the proper phase, and it may be said that in general this means a less condensed phase than that in which the molecule normally exists. The importance of this deduction from the present theory is manifest. It at once gives an explanation of the fact that so many reactions will not take place without energy being supplied to the molecules, and moreover, it enables us to calculate the exact increment of energy required by each molecule. This increment of energy amounts to one or more molecular quanta, depending on the initial and reactive phases. There is no method at present known of directly measuring the size of the molecular quantum, but it may be obtained by multiplying the molecular frequency, which can readily be observed, into the time factor, and for this we may use the Planck constant 6.57

$\times 10^{-27}$. If the initial and reactive phases are known, the necessary increment of energy for one molecule may be found.

There are two methods of supplying the increment of energy required for the phase change. In the first place the molecule may be exposed directly to a source of radiant energy in the form of heat or light, and in the second place the energy may be supplied by a material catalyst. Whilst the first method may be readily understood, the action of a catalyst requires some explanation. It was pointed out above that in those cases where the external atomic fields are unequally balanced the molecular force field condensation will not proceed very far owing to the uncompensated balance of affinity of one type. If such a molecule forms an addition complex with another molecule by virtue of this uncompensated balance, there will now be nothing to prevent the force field condensation from proceeding further with the evolution of one or more molecular quanta. If the second molecule in the complex has the same infra-red frequency as the first, the one or more quanta given up by the first molecule may be absorbed by the second molecule, with the result that the latter is converted into a less condensed or more reactive phase. This explanation of the change of phase produced by a solvent can readily be put to the test of experiment. In the first place the infra-red frequencies of the two, solute and solvent, must be similar, and in the second place if the solute molecule is converted into a less condensed phase the solvent molecule must pass into a more condensed phase. It has been found that when two molecules form an addition complex, this complex does not exhibit the molecular frequencies of its two components, but a molecular frequency of its own. The mechanism for the transference of one or more molecular quanta from one molecule to the other is therefore perfect. Again, some recent investigations appear to show that in such a complex, when one component passes into a less condensed phase, the other component passes into a more condensed phase. The explanation of the effect of a solvent in changing the phase of a molecule is thus experimentally verified. It may be stated that although this explanation has been given for the particular case of a solvent and solute, it undoubtedly applies to all cases of catalysis. A catalyst may be defined as a substance which by virtue of its power of forming an addition complex with the catalyte converts the latter into a less condensed and more reactive phase, itself passing into a more condensed phase.

It will be evident that the deductions made from the three original assumptions as to the existence of elementary atomic quanta lead to a radiation theory of chemical reaction, a theory which differs from the better known theories in the essential fact that it does not rest on a basis of monochromatic radiation. The deductions made from this theory may be briefly recapitulated. The existence is established of simple integral relationships between the various frequencies exhibited by a molecule and of the combination of these frequencies to form subsidiary frequencies within the absorption bands. These relationships have all been observed.

A molecule must exist in one of a number of possible phases, any two consecutive phases differing in energy content by one molecular quantum of energy. Each phase is characterised by its own phase quantum and phase frequency, and each phase is endowed with its own specific reactivity. A molecule must be brought into the appropriate phase before it can take part in a reaction. Since a molecule in the free state exists in a more condensed phase than the one desired, it is necessary to supply energy to the molecule to produce the phase change. This increment of energy is exactly equal in amount to one or more molecular quanta, the number depending upon the difference between the initial and reactive phases. The energy can be gained by the molecule on exposure to radiation of frequency equal to its atomic, intra-molecular, or phase frequency. Changes of phase produced by heat and by light have frequently been observed. The effect of temperature is due to the summation within the molecule of an integral number of atomic or intra-molecular quanta to give the one or more molecular quanta required. When the phase change is produced by the absorption of a phase quantum, the balance of energy over that required is radiated as fluorescence or phosphorescence. The increment of energy may be supplied by a material catalyst which forms an addition complex with the molecule in question. Within this complex one or more molecular quanta are given to the reactant molecule by the catalyst molecule, the former passing into a less condensed, the latter into a more condensed phase.

Mention may be made of the experimental evidence in support of this theory. The integral relationships between the frequencies exhibited by a molecule and the change of *phase exhibited by a catalyst* have already been dealt with. The most important confirmation of the theory is to be found in the explanation which it gives of the discrepancy observed between the actual and calculated number of reacting molecules. The better known theories make the very simple, not to say obvious, assumption that a minimum of one energy quantum is necessary to activate a single molecule. From a knowledge of the energy absorbed in any given reaction and the frequency characteristic of the reacting molecules it is easy to calculate the number of molecules which should have reacted. In general the actual number is many million times larger than the calculated number, the divergence of the observed from the calculated number being different in different cases.

These monochromatic theories, however, take no cognisance of the destination of the energy that has been absorbed. The application of the present theory will be understood more easily from a particular case which has been quantitatively studied, namely, the photochemical union of hydrogen and chlorine. As is well known, this reaction proceeds when the mixture of gases is exposed to radiation of frequency equal to that characteristic of chlorine. The equation for single molecules will be

$$H_2 + Cl_2 + E = 2HCl + E + K,$$

where E is the amount of energy absorbed by the chlorine molecule, *i.e.*, one phase quantum, and K is the observed heat of reaction for the formation of two molecules of HCl. For the present purpose it is of no consequence whether the amount E is or is not the minimum amount necessary to activate a chlorine molecule. The sole point of importance is that E is exactly one phase quantum characteristic of the free chlorine molecule. During a reaction two molecules of HCl are formed and the energy E + K is radiated. This energy is radiated by the HCl at infra-red frequencies characteristic of the HCl molecule. The quantity E cannot be radiated by the chlorine, for if it were so radiated the chlorine would lose its reactivity. Now the HCl molecule has at any rate some infra-red frequencies identical with those of chlorine, and consequently the energy E + K can be re-absorbed by the surrounding Cl_2 molecules with the result that these become partially or wholly activated. Since in this reaction K is positive, the reaction being exothermic, the number of molecules of chlorine that react will very greatly exceed that calculated on the basis of one for every phase quantum absorbed, the excess depending upon the proportion of the energy E + K that is re-absorbed. The only condition under which observation and calculation can agree is when K is numerically equal to E and is negative, so that E + K = 0.

The proportion of the radiated energy *that is re-absorbed will obviously depend* on two factors, the density of the chlorine and the density of the radiation. According to the present theory, therefore, the divergence from Einstein's law of one molecule reacting her phase quantum absorbed will increase, both when the density of the chlorine is increased and when the density of the radiation is increased, or what comes to the same thing, when the intensity of the incident light is increased. It has already been proved that with constant intensity of illumination the velocity of the reaction is proportional to the square of the concentration of the chlorine. Several other instances of the increase of the divergence from Einstein's law with increase in concentration under constant illumination have been noted. It has recently been shown also that the divergence from Einstein's law increases very rapidly with increasing intensity of the illumination. Three observations of some interest were made in these latter experiments. During the first instant of illumination the reaction must obey Einstein's law, but the re-absorption of the radiated energy will at *once commence with the result that the* rate of the reaction with moderate intensities of light will rapidly increase up to a constant maximum depending upon the *proportion that is re-absorbed*. This phenomenon was observed in every case.

Since the proportion re-absorbed increases with intensity of illumination, a condition will be reached with increasing illumination when the proportion re-absorbed will be sufficient completely to activate the surrounding chlorine molecules. Under this condition the reaction once started by the absorption of a single phase quantum will pass as an explosion wave through the whole mixture. The existence of a lower limit to the intensity of the illumination necessary to cause the explosive combination of hydrogen and chlorine has long been recognised.

The third phenomenon observed is one of very great interest. If the activating source of light be cut off when the maximum rate of reaction has been reached, the reaction ceases at once, but it is very surprising how long an interval of time must elapse before the chlorine reaches its normal condition, since at least thirty minutes are required. If the light be allowed to fall on the mixture before this minimum period of rest has expired the initial rate of reaction is greater than the normal initial rate. The obvious explanation is the presence of partially activated chlorine molecules, that is to say molecules containing more than their normal number of atomic quanta, which, however, do not in the case of any one molecule amount in their sum to the increment of energy necessary for complete activation. This condition is readily understood from the present theory, and raises the possibility of two samples of the same gas apparently in thermal equilibrium with one another but having different energy contents. It is hardly necessary to point out that all the phenomena observed in the photochemical union of hydrogen and chlorine, originally foretold from the present theory and recently proved experimentally, cannot be explained by any monochromatic theory of reaction.

An extension of the principle of the re-absorption of the radiated energy may be mentioned, namely the photocatalysis of a reaction whereby a molecule is activated, when screened from rays of its characteristic frequency, by other molecules which in absorbing their own molecular quanta emit infra-red rays, these being absorbed by the first molecule. Evidently this will be possible if the two molecules have the same atoms in common. It is only necessary here to record the fact that several reactions have been successfully photocatalysed, and of these not the least interesting is the formation of formaldehyde from carbon dioxide and water in visible light in the presence of certain coloured bases such as malachite green. As is well known the characteristic frequency of carbon dioxide lies in the very extreme ultra-violet and in the absence of the photocatalyst the synthesis of formaldehyde requires radiation of that frequency.

Finally a brief reference may be made to some further observations which have not yet been published. The possibility of the existence of two samples of the same gas in apparent thermal equilibrium with one another but in different molecular phases has already been mentioned. This phenomenon is somewhat strikingly exemplified by ammonia and its decomposition by an electrically heated platinum wire. With a constant current the amount of ammonia decomposed in a given time depends on the condition of the gas. When the ammonia is prepared by the very slow evaporation of the liquefied gas or by warming its concentrated aqueous solution, the amount decomposed is many times larger than when the gas is obtained by the rapid evaporation of the liquid, the temperature of the two samples and the amount of energy supplied to them being exactly the same. On standing for many hours the "inactive" ammonia tends to reach the normal condition.

Many substances are known which exist in different molecular phases in the gaseous and liquid states, and in all probability ammonia is analogous in this respect. The very rapid evaporation of the liquid will give a gas containing a greater proportion of its molecules in the more condensed phase than is normal. The result will be that a given amount of energy will decompose fewer molecules than in the case of normal ammonia.

Instances might be multiplied of the application of this theory to chemical reaction but sufficient has been said to justify the original claim that it is possible from the assumption of elementary atomic quanta to formulate a theory which accords better with the observed facts than the theories of monochromatic radiation.

(From "Transactions of the Faraday Society," Vol. XVII., Part 3.)

LABORATORY EXPERIMENTS ON THE EXTRACTION OF MESOTHORIUM FROM MONAZITE SAND.

By Herman Schlundt.*

(Continued from Page 141.)

Fully two-thirds of the combined losses in the liquors was confined to one of the acid liquors. Though the investigators were at first inclined to attribute the major portion

* *From a paper on Mesothorium, published by the Department of the Interior, Bureau of Mines, Washington.*

of this loss to chemical action, later, after examination of the sediment in this liquor, it was concluded that the loss was almost entirely mechanical, barium sulphate having been carried over in the wash liquors when they were siphoned off. The loss of values in the unattacked sands appears to correspond to the weight. In the first run the tailings constituted 9.4 per cent. of the monazite sand treated, and the radium found was 8.3 per cent. In the second run the unattacked sands constituted 6.1 per cent. of the weight of the ore, and the percentage of radium found was 5.85 per cent.

In conducting the analytical work, determinations were generally made in duplicate or triplicate by at least two methods. In the estimation of radium, for example, in monazite, and the concentrates, the two methods have already been outlined. By following this plan throughout the investigation it was learned that several of the methods of analysis required modification.

The radium determinations in monazite sand gave values 5 per cent. higher when the ore was decomposed by fusion with mixed carbonates instead of sulphuric acid, therefore it was concluded that the residue that was unattacked by sulphuric acid held materials containing radium. This conclusion found confirmation in the radium determinations made on the unattacked sands by both methods. When the emanation was separated directly by boiling with concentrate sulphuric acid, the values were scarcely a third as high as those obtained by first decomposing the tailings by fusion with mixed alkali carbonates.

Determinations of Lead and Barium in the Concentrate.

In the first method of analysis the lead and barium were extracted with concentrated sulphuric acid, and the recovered sulphates were then refined by fusion with mixed alkali carbonate, and finally after separation were precipitated as sulphates. As the percentages of lead and barium found in this method stand in close agreement with the results obtained by direct fusion of the concentrate with mixed alkali carbonates, confidence was gained in the method of determining radium in the concentrate, when the emanation is separated by boiling samples with concentrated sulphuric acid. The fact that lead and barium can be extracted quantitatively from the crude concentrate with concentrated sulphuric acid also suggests a possible method of refining this product on a commercial scale.

In the analytical determinations 5-gram samples of the concentrate were boiled for 10 minutes with 120 cc. of chemically pure sulphuric acid. After cooling somewhat, the insoluble residue was filtered off on a Gooch crucible with asbestos mat, and washed twice with hot concentrate acid. From the filtrate, lead and barium were precipitated by dilution with two to three litres of water. The recovered sulphates were then refined by fusion with mixed carbonates and the washed carbonates were converted into chlorides. To separate the lead the filtrate was made barely alkaline with ammonia, and then saturated with hydrogen sulphide. In the filtrate barium was precipitated as sulphate; lead was also estimated as sulphate in the solution obtained by dissolving the precipitate of lead sulphide in dilute nitric acid.

In the other method, 5-gram samples of the crude concentrate were used directly with mixed carbonates in nickel crucibles. An insoluble residue of nearly 10 per cent. generally remained when the washed carbonates were treated with dilute hydrochloric acid. A second and third fusion, however, did not yield additional barium or lead. In the concentrate from run No. 2 the writer found 46.56 per cent. of barium sulphate by extraction with sulphuric acid and 47.26 per cent. by direct fusion with mixed carbonates. In run No. 2 the lead content of concentrate was estimated as at least 21 per cent. sulphate. This high percentage of lead sulphate in concentrate No. 2 explains an observation made subsequently in connection with experiments on refining the crude concentrate. When heated, much sulphur dioxide is liberated at about 600° C., probably as the result of the interaction of lead sulphide formed by the reduction of some of the lead sulphate by carbon, with unreduced lead sulphate.

Refining of Mesothorium in the Crude Concentrate.

The method finally employed for extracting the barium in the two batches of crude concentrate that was obtained in experimental runs 1 and 2, and for obtaining it in soluble form, followed closely the process used in refining the "first sulphates," produced in the extraction of radium from carnotite ores. The barium sulphate carrying the radium at a concentration of about 1 mg. kilo was intimately mixed with char-

oal, and was then reduced to sulphide at bout 1000° C. The reduced product when eached with hydrochloric acid gave a soluon of barium chloride, ready for further oncentration of mesothorium by fractional ystallisation.

Before adopting the direct reduction ethod, a number of laboratory experiments were conducted with 5, 10, 50, and 00-gram samples of the crude concentrates f mesothorium-barium, with a view to ecuring data on other methods of possible ractical value.

In outlining the methods of analysis attention was directed to the quantitative exraction of barium from the concentrate by igesting it with a large excess of concenrate sulphuric acid. In order to insure the arium being completely dissolved in the oncentrate it must be boiled with at least x times its weight of acid. About 40 per ent. of the material remains unattacked. When the black residue is filtered off on a action filter fitted with asbestos mat and ashed with two portions of hot concenrate sulphuric acid, fully 95 per cent. of e barium may be recovered upon diluting e acid liquor with 10 to 15 times its olume of water. The partly refined sulhate thus obtained may be converted alost quantitatively into soluble form by ne of three methods: (1) Reduction to sulhide at high temperatures by carbon; (2) onversion into carbonates by fusion in iron ettles with a mixture of sodium hydroxide, part, to soda ash, 2 to 3 parts, leaching of e fused mass, washing free from sulhates, and conversion of the insoluble carnates into chlorides—recoveries running s high as 97 per cent. were obtained by is method; (3) prolonged boiling of the rened sulphates with a concentrated solution f sodium carbonate about four times in xcess of the sulphates present. With conant stirring by means of a mechanical irrer during the digestion period, converons as high as 92 per cent. were obtained. ethods 2 and 3 can be applied directly to e crude concentrate with equally good reults. More than 20 preliminary experients of this character were conducted ith 50-gram samples of concentrate before e decision was reached to treat the main ulk of the concentrate by direct reduction ith carbon as the first step in refining.

In the early reduction experiments, 500am charges were carried through and the mount of soluble barium determined. At rst enough powdered charcoal or lampblack was mixed with the crude concentrat to reduce all of the barium and lead sul phates. In the course of the experiments it was soon noted that the residue remainin after the reduced product had been leache with hydrochloric acid was nearly as bulk as the original charge. Furthermore, som experiments to determine the loss on igni tion revealed the reduction of a large frac tion of the sulphates. In short, it soon be came evident that the admixture of graphit and amorphous carbon present in the crud concentrate was more than enough to re duce the sulphates completely. The con centrates from the two experimental run were reduced in the technological labora tory of the United States Bureau of Mine at Golden, Colo., and later, after it wa found that the concentration of mesothor ium by fractional crystallisation of th chlorides and bromides proceeded normally two other batches of concentrates weighing respectively, 349 and 745 pounds,* wer given this treatment in the plant of th Welsbach Co. The reductions were carrie out in graphite crucibles with 30-poun charges heated 4 to 5 hours at 1100° C. an sometimes even higher. The recovery o values and the losses in the various pro ducts were investigated throughout the ex periments by two distinct methods of analy sis: The chemical method involving deter minations of barium, and the radioactiv method, embracing comparisons of gamma ray activities and determination of radiun by the emanation method.

* *Experimental data are given for a par of this concentrate,* 179.3 *kg., in Table* 8.

THE PULP AND PAPER INDUSTRY OF CANADA.

One of the outstanding features of Can ada's manufacture and commerce in th last two decades has been the rapid growt of the pulp and paper industry. Thi growth resulted primarily from the juxta position of large supplies of suitable pulp wood timber and cheap electrical energy Large areas of coniferous forest traverse by rushing streams and rivers, providin water power, form the basis upon whic the industry has been built up.

Forty years ago there were only 5 mill in operation in Canada; to-day there ar

more than 120, consuming over two million cords of pulpwood per annum and using hydro-power to the extent of 637,000 h.p. In 1921 the capital invested exceeded 380 million dollars, while the value of products was over two hundred million dollars.

Export Trade.

From the point of view of the Dominion's export trade, the pulp and paper industry holds a position that is second only to that of agriculture. The figures given below give a comparison of the exports of the products (animal and vegetable) of Canada's farms with pulp and paper exports, for the years indicated:—

Year	Farm Produce (Millions of dollars)	Pulp and Paper (Millions of dollars)
1914	245.9	19.1
1923	467.1	122.6

The rapid progress of the pulp and paper industry as a contributor to Canada's trade is shown in the following table of the exports of pulp and paper for the past twelve years:—

Year	Paper prod. (Millions of dollars)	Wood-pulp (Millions of dollars)	Total (Millions of dollars)
1912	3.9	5.1	9.0
1913	6.3	5.5	11.8
1914	12.7	6.4	19.1
1915	15.5	9.3	24.8
1916	20.0	10.4	30.4
1917	26.1	20.4	46.5
1918	37.7	25.6	63.3
1919	47.9	34.7	82.6
1920	63.2	41.4	104.6
1921	92.1	71.6	163.7
1922	69.5	35.9	105.4
1923	79.6	43.0	122.6

The great fluctuations in price in the years 1920-22 affected to some extent the generally steady increase in production. Since that period, however, it will be noted that the increase has been resumed.

Figures of the total production of wood-pulp are available for a number of years back. Those for newsprint paper (which forms from 80 to 85 per cent. of the total) are available for certain years, and these tell the same story of progress as the exports.

Year	Wood-pulp (tons)	News-print (tons)
1917	1,464,308	689,847
1919	1,716,089	794,567
1921	1,549,082	805,114

Subsidiary Industries.

Although large supplies of pulpwood and lime are readily available in Canada, the pulp and paper mills are at present importers of many of the raw materials entering into the manufacture of chemical pulps and paper. In the fiscal year ending March 31, 1923, sulphur valued at $1,673,662 was imported chiefly from the extensive Louisiana sulphur deposits; of this amount, about three-fifths was used in the pulp and paper industry. Sulphur can be produced from the domestic deposits of pyrites, but under present conditions cannot compete with the imported brimstone. Imports of alum and salt cakes amounted to over $1,000,000, of which seven-tenths was used in the manufacture of kraft pulp. Canada's dependence upon outside sources for this chemical will probably diminish as the sodium sulphate deposits of the Prairie Provinces are gradually developed. Again, though kaolin or China clay is produced in small quantities in the province of Quebec the value of imported clay used in the pulp and paper industry amounts to about $200,000 yearly. Other products which are imported include resin, alum, pulp-stones, acid proof refractories, and soapstone linings. Some of these are being produced in Canada and as the pulp and paper industry grows, a large enough market will become available to warrant the development of Canada's resources for these commodities.

These facts are another reminder of the importance of Canada's forests and of the need for the adoption of all possible measures for their conservation.

GENERAL NOTES.

AIRCRAFT APPRENTICES FOR THE ROYAL AIR FORCE.

The Air Ministry announces:—

The decision of the Government to increase the strength of the Royal Air Force for Home Defence purposes necessitates the engagement of aircraft apprentices, who will be trained as skilled craftsmen, in largely increased numbers.

For the entry in January next, approximately 950 boys of a good class will be required. The selection to fill these vacancies will be made on the results of two competitive examinations, which are conducted re-

spectively by the Civil Service Commissioners and by the Air Ministry in conjunction with the local Educational Authorities throughout the country.

Candidates must be physically fit and be between 15 and 16½ at the time of entry, although in the case of the Air Ministry examination the upper age limit is, under certain conditions, extended to 17 years.

The syllabus, which is the same in both examinations, consists of mathematics, experimental science, English, and a general paper, and has been designed to be suitable for boys still at school and following a normal course of instruction.

The closing date for entries for the Civil Service examination is August 30. This examination will be conducted by the Commissioners at the following centres:—London, Birmingham, Belfast, Chatham, Edinburgh, Plymouth, and Portsmouth. Applications to sit at this examination should be made at once to the Secretary, Civil Service Commission, Burlington Gardens, London, W.1. The entry fee is 5s.

The Air Ministry examination is confined to boys nominated by the local Education Authorities of the country and by the governing bodies of certain approved schools and associations. The closing date for entry is October 2. For this examination there is no entry fee.

Boys who are still at school, who wish to compete in the Air Ministry examination, should make application to their headmasters with a view to securing a nomination from the Education Authorities responsible for the school. In the case of boys who have left school, application may be made to the Advisory Committee for Juvenile Employment in the area, while boy scouts can apply to the authorities of the Boy Scout Association, and Territorial Cadets to the officer commanding their unit.

When appointed as aircraft apprentices, boys are given three years' training in a skilled trade and general education by civilian schoolmasters during this period up to the standard of a good technical school. The principal trades open to boys, who are invited in advance to indicate their preference, are carpenter-rigger, fitter, coppersmith, wireless operator mechanic, electrician, instrument maker and draughtsman. In assigning boys to the various trades, every endeavour is made to give effect to each boy's individual preference, the wishes of the boys in this respect being considered in the order of their position on the examination list.

During the period of training there is careful supervision of health and general welfare, medical attendance, religious instruction from the chaplains of several denominations, and recreation facilities. Six weeks' annual leave is granted.

Pay is given, under existing regulations, at 1s. 6d. a day until the age of 18, and then at 3s. a day until the course is completed.

At the end of the course the aircraft apprentice must sit a passing-out examination for promotion to the rank of leading aircraftsman with pay varying from 5s. 2d. to 5s. 6d. per day. The above rates may be subject to revision in the immediate future. Those boys who do not qualify for the highest grade will be appointed as aircraftsmen with slightly lower commencing rates of pay.

A certain number of the leading apprentices are sent on completion of their course to the Royal Air Force Cadet College, for training as commissioned officers. Others are given an advanced course, and are eventually appointed as N.C.O.s with the rank of corporal. There is also a reasonable chance of selection for a further number to qualify later in flying to become airmen pilots, and generally there is an opportunity for promotion to the senior N.C.O. and warrant officer ranks, and later to commissioned rank.

Headmasters and others interested in the scheme can obtain copies of the regulations for entry (A.P.134), on application to the Secretary, Air Ministry, Kingsway, W.C.2.

INSULIN AND DIABETES.

The subject of diabetes and its cure was discussed at the British Medical Association on July 25th, at Portsmouth.

Sir Thomas Horder presided over the "Medicine" Section, and in opening a discussion on diabetes said that the fact which led them to choose diabetes for their first debate was, of course, the introduction of insulin as a remedy for the disease. If they did not discuss insulin at that meeting of the association their patients would be much surprised, and with good reason. They would probably assume, again with reason, that in insulin the profession had a "cure" for diabetes, and that nothing more need be said on the matter. Sir Thomas Horder continued:—

"I am afraid a good many persons have already assumed this, and perhaps such an assumption is not surprising in view of certain generalisations that have got abroad, and which, if they do not carry the hall-mark of authority, at least have not been authoritatively contradicted." It might be, the speaker added, "that the successful preparation of this internal secretion (insulin) of the pancreas would prove to be as great an asset to medical science by assisting the interpretation of phenomena hitherto obscure as in the provision of a therapeutic agent in diabetes. Only a superficial hearer would read into that remark a detraction from the great value of Dr. Banting's discovery. in reality such remarks enhanced its value. Had not the essence of the problem of diabetes hitherto been the almost certain fact that under that name we had been dealing not with one biochemical disturbance only, but with several? It seemed probable that the use of insulin, controlled by careful observations, would not only still further establish that fact, but would also help to mark off. much more clearly than before, certain very different types of cases of diabetes met with in practice." Sir Thomas Horder then said:—

"One result of this segregation we are already observing: certain cases of diabetes are benefited much less by insulin than are others, and this is so even when we make due allowance for all those collateral points in the dietetic part of the treatment, attention to which we know to be so important. Certain cases will doubtless be found not to be benefited at all. And if we do not make this position quite clear we shall see many patients suffer the bitter nemesis of disappointment after entertaining a false hope for which we may, quite unwittingly, have been partly responsible."

There were a number of questions which must be discussed. Sir Thomas enunciated them in detail, and thereafter called on Dr. Banting, to whom he extended a hearty welcome.

Dr. F. G. Banting, of Toronto, the discoverer of insulin, said that it would be several years before the limits of the effectiveness of insulin were known. As to patients giving themselves insulin, he quoted the case of the American commercial traveller who carried his own insulin and syringe, and described the daily application of it as being no more difficult than the morning shave. After a warning against this practice, Dr. Banting described the experiments which led to the discovery of insulin by observing that a dog became diabetic after its pancreas had been excised. It was then found that if they ligatured the duct coming from the pancreas to the intestines they would necessarily prevent the passage of any "external" secretion. Nevertheless, though this procedure caused the pancreas to become atrophied the dog did not become diabetic. Evidently, therefore, there was an "internal" secretion which went straight into the blood stream. The structure of the pancreas was submitted to examination, and it was found to consist of two parts, namely, the main gland and some small islands of cells. The "internal" secretion, which was the active principle, "insulin," came from these cells. Further experiments were still being made. He pointed out that the discovery of insulin threw no light on the causes of diabetes.

DEATH OF EDWARD KNOWLES MUSPRATT.

Liverpool has lost a notable scientist and business man by the death, on the 1st inst., of the above. He was born at Linacre, near Bootle, on November 6, 1833. He was sent to a school at Worksop, conducted on Pestalozzi's principles, where much attentior was paid to science and modern languages In the holidays he saw a good deal of hi father's friends, who included Dickens Lover, Sheridan Knowles, the dramatis (who was the boy's godfather), Jerrold Lemon, Forster, and Charlotte Cushman the actress, and her sister Susan, who mar ried Muspratt's brother.

In 1850 he was sent to study at Giessen the university of the great chemist, Justu von Liebig, who became an intimate frien of the family. After a year's preparation h was admitted to the senior laboratory, an mixed with men doing original researcl Liebig urged him to specialise in physi logical chemistry, and when he accepted chair at Munich, Muspratt went with him.

In the 'sixties Weldon's process for th recovery of manganese and Ludwig Mond process for the extraction of sulphur fro alkali waste were introduced in the Mu pratt works. In 1890 the businesses James Muspratt and Sons and Muspratt an Huntley were incorporated with others the United Alkali Company, of which Mu spratt was vice-chairman at his death.

ELECTRICALLY DEFLAGRATED MERCURY FILAMENT AS A FLASH LIGHT FOR INSTANTANEOUS PHOTOGRAPHY.

By Kyoji Suyehiro.

(*Jap. J. Phys.*, I. (1922), 97-100, with 1 fig. and 2 pl.)

Even for technical researches the necessity of taking an instantaneous photograph of very short exposure is not very seldom experienced. For obvious reasons, however, the use of a high tension spark is not convenient in a workshop or in a similar place. The author found that a flash light of very short duration could be obtained by exploding a mercury filament sealed in a glass capillary tube by means of an electric current passed through it. The applied voltage may be 100 volts or so. When the filament is under 0.2 mm. in diameter and the wall of capillary tube is very thin, the duration of the flash light may be shortened even to a hundred thousandth of a second. It was found that this flash light is given out from the mercury arc lit up for a short interval just after the explosion of the capillary tube.

Apart from the advantage of this method over the high tension spark with regard to its simplicity and safety, the merit of it lies in the fact that this may be used under water without any complication of arrangement.

NOTICES OF BOOKS.

Materie, Elektrizität Energie, von Dr. Walther Gerlach. Pp. 195. Dresden and Leipzig: Verlag von Theodor Steinkopff. 1923. Price 3s. 3d.

Prof. Gerlach's volume on Matter, Electricity and Energy forms one of the series of monographs on Natural Science, issued under the direction of Prof. Liesegang.

The author has undertaken the task of summarising the advances and developments in Atomic Science from the enormous volume of work which has been done during the last ten years. A good account is given of recent work on Isotopy; the elucidation of the structure of the Atom and the Atomic Nucleus; the changing of the physical state of the Atom; the application of line and X-ray spectra; analysis with the aid of X-rays; the physical basis of Photochemistry, etc. Prominence is also given to the author's own experimental contributions.

That the volume contains some of the most recent developments will be gathered from the inclusion of an account of the identification of the occurrence of Hafnium in Zirconium minerals by Coster and Hevesy. This has, however, been taken from German sources (*Naturwissenschaften*, 1923, Vol. VIII). It is indeed noticeable that much recent English and American research work has evidently escaped the author's attention. This is undoubtedly due to the prohibitive cost of English books and periodicals in Germany and most other European countries. Whilst the present unsettled state of affairs lasts, English publishers cannot hope for any Continental demand, and the dissemination of scientific knowledge will remain retarded.

As it is, foreign scientific publications are almost inaccessible to German scientists, who are obliged to rely upon the meagre abstracts in their *Centralblätter* for such information. The correctness of this is well illustrated by a perusal of the volume under review.

Prof. Gerlach's book summarises much recent work on the ultimate structure of matter, and should prove of value to chemists, physicists, and others interested in this subject.

We have received from Messrs. Robt. Boyle & Sons a booklet dealing with the ventilation of public buildings.*

The authors have devoted themselves to the study of ventilation on truly scientific lines, and have had a world-wide practical experience in the subject.

The book in question deals exhaustively with the practical application of ventilation, and it contains a fund of information as to the methods of ventilation adopted for the Houses of Parliament, the Guildhall, and other public buildings. The relative merits of natural and artificial ventilation are fully discussed, and the opinions of many eminent authorities are quoted.

The book will be found of great use not

* *The Ventilation of Public Buildings*, by Robert Boyle. Robert Boyle & Sons, London. Price 6s. net.

only to architects and builders, but to those responsible for public buildings generally, as it explains very clearly the principles involved in a successful system of ventilation, and also explains many of the failures that are unhappily often apparent in some of our important public buildings.

The work is well illustrated with drawings and diagrams that help greatly in understanding the theories advanced.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

20718—Canadian Electro Products Co., Ltd.—Manufacture of acetaldehyde. Aug. 15.

21022—*Christenson, O. L.—Producing ammonium* chloride from ammoniacal hot distillation or generator gases. Aug. 18.

20949—Neuss, O.—Manufacture of products from urea and formic aldehyde. Aug. 17.

21006—Pintsch Akt-Ges.—Process for obtaining nitric oxide. Aug. 18.

Specifications Published this Week.

201624—Galbraith, W. L., and Leacock, W., and Tallantyre, S. B. Manufacture of condensation products from carbazole and p-*nitrosophenol and its derivatives.*

190448—Leggo, A. V.—Furnaces or the like for ore-roasting or like operations.

Abstract Published this Week.

199886—Catalytic oxidation of organic compounds.—Badische Anilin & Soda Fabrik, Ludwig-*shafen-on-Rhine. Germany.*

Aldehydes; ketones; catalytic agents, preparation of.—The partial oxidation of organic compounds is effected by passing the compound in the gaseous or vapour phase, in admixture with an oxygen-containing gas, over boric or phosphoric acid or their salts. The catalytic materials are preferably mounted on a carrier; thus clay, fire-brick or magnesia is soaked with boric or phosphoric acid, or silica, kieselguhr, a metallic oxide, carbonate or nitrate is introduced into molten boric acid. Mixed catalysts, obtained by adding boric or phosphoric acid to molten metal salts such as nitrates, may be used. According to the examples, (1) formaldehyde is produced by passing ethylene and oxygen over boric or phosphoric acid or their salts mounted on burnt clay or diatomaceous earth; the gases may circulate over the contact mass, the formaldehyde being absorbed in water and further ethylene and oxygen being introduced continuously or at intervals; methane, acetone, ethyl alcohol and cyclohexanone may also be oxidised to formaldehyde in a similar way; (2) anthracene and air passed over the catalytic material yield anthraquinone, benzyl alcohol gives benzaldehyde, and ethyl alcohol produces acetaldehyde.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

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Session 1923-24.

(Commencing on Tuesday, 2nd October, 1923).

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THE CHEMICAL NEWS,

VOL. CXXVII. No. 3809.

[BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE: LIVERPOOL, 1923.]

THE PRESIDENTIAL ADDRESS. THE ELECTRICAL STRUCTURE OF MATTER.

By PROFESSOR SIR ERNEST RUTHERFORD, D.Sc., LL.D., PH.D., F.R.S.,

President of the Association.

It was in 1896 that this Association last met in Liverpool, under the presidency of the late Lord Lister, that great pioneer in antiseptic surgery, whose memory is held in affectionate remembrance by all nations. His address, which dealt mainly with the history of the application of antiseptic methods to surgery and its connection with the work of Pasteur, that prince of experimenters, whose birth has been so fittingly celebrated this year, gave us in a sense a completed page of brilliant scientific history. At the same time, in his opening remarks, Lister emphasised the importance of the discovery by Röntgen of a new type of radiation, the X-rays, which we now see marked the beginning of a new and fruitful era in another branch of science.

The visit to your city in [illegible] was for me a memorable occasion, for it was here that I first attended a meeting of this Association, and here that I read my first scientific paper. But of much more importance, it was here that I benefited by the opportunity, which these gatherings so amply afford, of meeting for the first time many of the distinguished scientific men of this country and the foreign representatives of science who were the guests of this city on that occasion. The year 1896 has always seemed to me a memorable one for other reasons, for on looking back with some sense of perspective we cannot fail to recognise that the last Liverpool meeting marked the beginning of what has been aptly termed the heroic age of Physical Science. Never before in the history of physics has there been witnessed such a period of intense activity when discoveries of fundamental importance have followed one another with such bewildering rapidity.

The discovery of X-rays by Röntgen had been published to the world in 1895, while the discovery of the radioactivity of uranium by Becquerel was announced early in 1896. Even the most imaginative of our scientific men could never have dreamed at that time of the extension of our knowledge of the structure of matter that was to develop from these two fundamental discoveries, but in the records of the Liverpool meeting we see the dawning recognition of the possible consequences of the discovery of X-rays, not only in their application to medicine and surgery, but as a new and powerful agent for attacking some of the fundamental problems of physics. The address of Professor J. J. Thomson, President of Section A, was devoted mainly to a discussion of the nature of the X-rays, and the remarkable properties induced in gases by the passage of X-rays through them—the beginning of a new and fruitful branch of study.

In applied physics, too, this year marked the beginning of another advance. In the discussion of a paper which I had the honour to read, on a new magnetic detector of electrical waves, the late Sir William Preece told the meeting of the successful transmission of signals for a few hundred yards by electric waves which had been given by Sir Oliver Lodge at the Oxford Meeting of this Association in 1894. It is startling to recall the rapidity of the development from such small beginnings of the new method of wireless intercommunication over the greatest terrestrial distances. In the last few years this has been followed by the even more rapid growth of the allied subject of radiotelephony as a practical means of broadcasting speech and music to distances only limited by the power of the transmitting station. The rapidity of these technical advances is an illustration of the close interconnection that must exist between pure and applied science if rapid and sure progress is to be made. The electrical engineer has been able to base his technical developments on the solid foundation of Maxwell's electromagnetic theory and its complete verification by the researches of Hertz, and also by the experiments of Sir Oliver Lodge in this University—a verification which was completed long before the practical possibilities o this new method of signalling had been generally recognised. The later advances in radiotelegraphy and radiotelephony have largely depended on the application of the results of fundamental researches on the properties of electrons, as illustrated in the

use of the thermionic valve or electron tube which has proved such an invaluable agent both for the transmission and reception of electric waves.

It is of great interest to note that the benefits of this union of pure and applied research have not been one-sided. If the fundamental researches of the workers in pure science supply the foundations on which the applications are surely built, the successful practical application in turn quickens and extends the interest of the investigator in the fundamental problem, while the development of new methods and appliances required for technical purposes often provides the investigator with means of attacking still more difficult questions. This important reaction between pure and applied science can be illustrated in many branches of knowledge. It is particularly manifest in the industrial development of X-ray radiography for therapeutic and industrial purposes, where the development on a large scale of special X-ray tubes and improved methods of excitation has given the physicist much more efficient tools to carry out his researches on the nature of the rays themselves and on the structure of the atom. In this age no one can draw any sharp line of distinction between the importance of so-called pure and applied research. Both are equally essential to progress, and we cannot but recognise that without flourishing schools of research on fundamental matters in our universities and scientific institutions technical research must tend to wither. Fortunately there is little need to labour this point at the moment, for the importance of a training in pure research has been generally recognised. The Department of Scientific and Industrial Research has made a generous provision of grants to train qualified young men of promise in research methods in our scientific institutions, and has aided special fundamental researches which are clearly beyond the capacity of a laboratory to finance from its own funds. Those who have the responsibility of administering the grants in aid of research both for pure and applied science will need all their wisdom and experience to make a wise allocation of funds to secure the maximum of results for the minimum of expenditure. It is fatally easy to spend much money in a direct frontal attack on some technical problem of importance when the solution may depend on some addition to knowledge which can be gained in some other field of scientific inquiry possibly at a trifling cost. It is not in any sense my purpose to criticise those bodies which administer funds for fostering pure and applied research, but to emphasise how difficult it is to strike the correct balance between the expenditure on pure and applied science in order to achieve the best results in the long run.

It is my intention this evening to refer very briefly to some of the main features of that great advance in knowledge of the nature of electricity and matter which is one of the salient features of the interval since the last meeting of this Association in Liverpool.

In order to view the extensive territory which has been conquered by science in this interval, it is desirable to give a brief summary of the state of knowledge of the constitution of matter at the beginning of this epoch. Ever since its announcement by Dalton the atomic theory has steadily gained ground, and formed the philosophic basis for the explanation of the facts of chemical combination. In the early stages of its application to physics and chemistry it was unnecessary to have any detailed knowledge of the dimensions or structure of the atom. It was only necessary to assume that the atoms acted as individual units, and to know the relative masses of the atoms of the different elements. In the next stage, for example, in the kinetic theory of gases, it was possible to explain the main properties of gases by supposing that the atoms of the gas acted as minute perfectly elastic spheres. During this period, by the application of a variety of methods, many of which were due to Lord Kelvin, rough estimates had been obtained of the absolute dimensions and mass of the atoms. These brought out the minute size and mass of the atom and the enormous number of atoms necessary to produce a detectable effect in any kind of measurement. From this arose the general idea that the atomic theory must of necessity for ever remain unverifiable by direct experiment, and for this reason it was suggested by one school of thought that the atomic theory should be banished from the teaching of chemistry, and that the law of multiple proportions should be accepted as the ultimate fact of Chemistry.

While the vaguest ideas were held as to the possible structure of atoms, there was a general belief among the more philosophically minded that the atoms of the elements could not be regarded as simple un-

connected units. The periodic variations of the properties of the elements brought out by Mendeléef were only explicable if atoms were similar structures in some way constructed of similar material. We shall see that the problem of the constitution of atoms is intimately connected with our conception of the nature of electricity. The wonderful success of the electromagnetic theory had concentrated attention on the medium or ether surrounding the conductor of electricity, and little attention had been paid to the actual carriers of the electric current itself. At the same time the idea was generally gaining ground that an explanation of the results of Faraday's experiments on electrolysis was only possible on the assumption that electricity, like matter, was atomic in nature. The name "electron" had even been given to this fundamental unit by Johnstone Stoney, and its magnitude roughly estimated, but the full recognition of the significance and importance *of this conception belongs to the* new epoch.

For the clarifying of these somewhat vague ideas, the proof in 1897 of the independent existence of the electron as a mobile electrified unit, of mass minute compared with that of the lightest atom, was of extraordinary importance. It was soon seen that the electron must be of a constituent of all the atoms of matter, and that optical spectra had their origin in their vibrations. The discovery of the electron and the proof of its liberation by a variety of methods from all the atoms of matter was of the utmost significance, for it strengthened the view that the electron was probably the common unit in the structure of atoms which the periodic variation of the chemical properties had indicated. It gave for the first time some hope of the success of an attack on that most fundamental of all problems—the detailed structure of the atom. In the early development of this subject science owes much to the work of Sir J. J. Thomson, both for the boldness of his ideas and for his ingenuity in developing methods for estimating the number of electrons in the atom, and of probing its structure. He early took the view that the atom must be an electrical structure, held together by electrical forces, and showed in a general way lines of possible explanation of the variation of physical and chemical properties of the elements, exemplified in the periodic law.

In the meantime our whole conception of the atom and of the magnitude of the forces which held it together were revolutionised by the study of radioactivity. The discovery of radium was a great step in advance, for it provided the experimenter with powerful sources of radiation specially suitable for examining the nature of the characteristic radiations which are emitted by the radioactive bodies in general. It was soon shown that the atoms of radioactive matter were undergoing spontaneous transformation, and that the characteristic radiations emitted, viz., the α, β, and γ rays, were an accompaniment and consequence of these atomic explosions. The wonderful succession of changes that occur in uranium, more than thirty in number, was soon disclosed and simply interpreted on the transformation theory. The radioactive elements provide us for the first time with a glimpse into Nature's laboratory, and allow us to watch and study but not control the changes that have their origin in the heart of the radioactive atoms. These *atomic explosions involve energies which* are gigantic compared with those involved in any ordinary physical or chemical process. In the majority of cases an α particle is expelled at high speed, but in others a swift electron is ejected often accompanied by a γ ray, which is a very penetrating X-ray of high frequency. The proof that the α particle is a charged helium atom for the first time disclosed the importance of helium as one of the units in the structure of the radioactive atoms, and probably also in that of the atoms of most of the ordinary elements. Not only then have the radioactive elements had the greatest direct influence on natural philosophy, but in subsidiary ways they have provided us with experimental methods of almost equal importance. The use of α particles as projectiles with which to explore the interior of the atom has definitely exhibited its nuclear structure, has led to artificial disintegration of certain light atoms, and promises to yield more information yet as to the actual structure of the nucleus itself

The influence of radioactivity has also extended to yet another field of study of fascinating interest. We have seen that the first rough estimates of the size and mass of the atom gave little hope that we could detect the effect of a single atom. The discovery that the radioactive bodies expel actual charged atoms of helium with enormous energy altered this aspect of the problem. The energy associated with a single α particle is so great that it can read-

ily be detected by a variety of methods. Each α particle, as Sir Wm. Crookes first showed, produces a flash of light easily visible in a dark room when it falls on a screen coated with crystals of zinc sulphide. This scintillation method of counting individual particles has proved invaluable in many researches, for it gives us a method of unequalled delicacy for studying the effects of single atoms. The α particle can also be detected electrically or photographically, but the most powerful and beautiful of all methods is that perfected by Mr. C. T. R. Wilson for observing the track through a gas not only of an α particle but of any type of penetrating radiation which produces ions or of electrified particles along its path. The method is comparatively simple, depending on the fact, first discovered by him, that if a gas saturated with moisture is suddenly cooled each of the ions produced by the radiation becomes the nucleus of a visible drop of water. The water-drops along the track of the α particle are clearly visible to the eye, and can be recorded photographically. These beautiful photographs of the effect produced by single atoms or single electrons appeal, I think, greatly to all scientific men. They not only afford convincing evidence of the discrete nature of these particles, but give us new courage and confidence that the scientific methods of experiment and deduction are to be relied upon in this field of inquiry; for many of the essential points brought out so clearly and concretely in these photographs were correctly deduced long before such confirmatory photographs were available. At the same time, a minute study of the detail disclosed in these photographs gives us most valuable information and new clues on many recondite effects produced by the passage through matter of these flying projectiles and penetrating radiations.

In the meantime a number of new methods had been devised to fix with some accuracy the mass of the individual atom and the number in any given quantity of matter. The concordant results obtained by widely different physical principles gave great confidence in the correctness of the atomic idea of matter. The method found capable of most accuracy depends on the definite proof of the atomic nature of electricity and the exact valuation of this fundamental unit of charge. We have seen that it was early surmised that electricity was atomic in nature. This view was confirmed and extended by a study of the charges carried by electrons, α particles, and the ions produced in gases by X-rays and the rays from radioactive matter. It was first shown by Townsend that the positive or negative charge carried by an ion in gases was invariably equal to the charge carried by the hydrogen ion in the electrolysis of water, which we have seen was assumed, and assumed correctly, by Johnstone Stoney to be the fundamental unit of charge. Various methods were devised to measure the magnitude of this fundamental unit; the best known and most accurate is Millikan's, which depends on comparing the pull of an electric field on a charged droplet of oil or mercury with the weight of the drop. His experiments gave a most convincing proof of the correctness of the electronic theory, and gave a measure of this unit, the most fundamental of all physical units, with an accuracy of about one in a thousand. Knowing this value, we can by the aid of electrochemical data easily deduce the mass of the individual atoms and the number of molecules in a cubic centimetre of any gas with an accuracy of possibly one in a thonsand, but certainly better than one in a hundred. When we consider the minuteness of the unit of electricity and of the mass of the atom this experimental achievement is one of the most notable even in an era of great advances.

The idea of the atomic nature of electricity is very closely connected with the attack on the problem of the structure of the atom. If the atom is an electrical structure it can only contain an integral number of charged units, and, since it is ordinarily neutral, the number of units of positive charge must equal the number of negative. One of the main difficulties in this problem has been the uncertainty as to the relative part played by positive and negative electricity in the structure of the atom. We know that the electron has a negative charge of one fundamental unit, while the charged hydrogen atom, whether in electrolysis or in the electric discharge, has a charge of one positive unit. But the mass of the electron is only 1/1840 of the mass of the hydrogen atom, and though an extensive search has been made, not the slightest evidence has been found of the existence of a positive electron of small mass like the negative. In no case has a positive charge been found associated with a mass less than that of the charged atom of hydrogen. This difference between positive and negative

electricity is at first sight very surprising, but the deeper we pursue our inquiries the more this fundamental difference between the units of positive and negative electricity is emphasised. In fact, as we shall see later, the atoms are quite unsymmetrical structures with regard to the positive and negative units contained in them, and indeed it seems certain that if there were not this difference in mass between the two units, matter, as we know it, could not exist.

It is natural to inquire what explanation can be given of this striking difference in mass of the two units. I think all scientific men are convinced that the small mass of the negative electron is to be entirely associated with the energy of its electrical structure, so that the electron may be regarded as a disembodied atom of negative electricity. We know that an electron in motion, in addition to possessing an electric field, also generates a magnetic field around it, and energy in the electromagnetic form is stored in the medium and moves with it. This gives the electron an apparent or electrical mass, which, while nearly constant for slow speeds, increases rapidly as its velocity approaches that of light. This increase of mass is in good accord with calculation, whether based on the ordinary electrical theory or on the theory of relativity. Now we know that the hydrogen atom is the lightest of all atoms, and is presumably the simplest in structure, and that the charged hydrogen atom, which we shall see is to be regarded as the hydrogen nucleus, carries a unit positive charge. It is thus natural to suppose that the hydrogen nucleus is the atom of positive electricity, or positive electron, analogous to the negative electron, but differing from it in mass. Electrical theory shows that the mass of a given charge of electricity increases with the concentration, and the greater mass of the hydrogen nucleus would be accounted for if its size were much smaller than that of the electron. Such a conclusion is supported by evidence obtained from the study of the close collisions of α particles with hydrogen nuclei. It is found that the hydrogen nucleus must be of minute size, of radius less than the electron, which is usually supposed to be about 10^{-13} cms.; also the experimental evidence is not inconsistent with the view that the hydrogen nucleus may actually be much smaller than the electron. While the greater mass of the positive atom of electricity may be explained in this way, we are still left with the enigma why the two units of electricity should differ so markedly in this respect. In the present state of our knowledge it does not seem possible to push this inquiry further, or to discuss the problem of the relation of these two units.

We shall see that there is the strongest evidence that the atoms of matter are built up to these two electrical units, viz., the electron and the hydrogen nucleus or proton, as it is usually called when it forms part of the structure of any atom. It is probable that these two are the fundamental and indivisible units which build up our universe, but we may reserve in our mind the possibility that further inquiry may some day show that these units are complex, and divisible into even more fundamental entities. On the views we have outlined the mass of the atom is the sum of the electrical masses of the individual charged units composing its structure, and there is no need to assume that any other kind of mass exists. At the same time, it is to be borne in mind that the actual mass of an atom may be somewhat less than the sum of the masses of component positive and negative electrons when in the free state. On account of the very close proximity of the charged units in the nucleus of an atom, and the consequent disturbance of the electric and magnetic field surrounding them, such a decrease of mass is to be anticipated on general theoretical grounds.

(*To be continued.*)

THE QUANTUM THEORY.

By R. F. Hunter, F.C.S.

(*Continued from Page* 147.)

When $\frac{T}{\beta_o v} > 0.9$

the term

$$\frac{e^{\beta_o v/t}\left(\frac{\beta_o v}{T}\right)^2}{(e^{\beta_o v/T}-1)}$$

approximates to the value 1, and hence our older expression is merely a first approximation, viz.:

$$Cv = 3\,R.$$

Unfortunately, Einstein's expression was shown to hold only in a quantitative manner, and further correction was necessary. This was undertaken by Debye.

The fallacy in Einstein's investigation lay in this way: Einstein assumed for the sake of simplicity that a vibrating particle only gives rise to monochromatic light and absorbs such; Debye, observing this, *worked out an expression for atomic heat* on the basis of absorption and emission of a number of vibration frequencies covering, as a matter of fact, the whole spectrum. He assumed firstly, that a vibrating atom in a solid cannot vibrate simply in S.H.M. with one frequency, but owing to the effect *of other neighbouring atoms and the probability of collision*, assumes a complex mode of *vibration*; the complex vibration being calculated by the method of Fourier. If the temperature, T, be a multiple of a characteristic constant $\frac{T}{\theta}$ for a substance,

Atomic heat is a universal function of $\frac{T}{\theta}$

Further, at low temperature, Debye deduced that the atomic heat of solids $\propto T^3$.

Hence the atomic heat would be $\propto T^3$.

Debye's expression for the energy, U, of a solid vol. V containing N atoms is of the form

$$U = \frac{9N}{V_m^3}\int_0^{V_m} \frac{h\nu}{e^{h\nu/kt} - 1}\,.\,\nu^2 d\nu \qquad (1)$$

Further, giving the constant θ, the meaning

$$\theta = \frac{h\nu_m}{k} = \beta\nu_m \qquad (2)$$

and introducing into (1) a new variable, without dimensions, $\xi = \frac{h\nu}{KT}$

one arrives at:

$$U = 9NkT\left(\frac{kT}{h\nu_m}\right)^3 \int^{h\nu_m/kT} \frac{\xi^3 d\xi}{e^{\xi} - 1} \qquad (3)$$

Substituting, one obtains:

$$U = 9NkT\left(\frac{T}{\theta}\right)^3 \int_0^{\theta/T} \frac{\xi^3 d\xi}{e^{\xi} - 1} \qquad (4)$$

Differentiating, one obtains:

$$C_v = 3Nk\left\{\frac{12}{\chi^3}\int_0^{\chi} \frac{\xi^3 d\xi}{e^{\xi} - 1} - \frac{3\chi}{e^{\chi} - 1}\right\} \qquad (5)$$

which is Debye's equation.

Debye's formula subjected to experimental tests proved to agree exceedingly well with experimental results.

Two theories which deserve mention before we pass on to the Rutherford Bohr theory, are the theories of Bjerrum and of Kruger.

The Bjerrum theory has been of considerable use in the question of the rotational spectrum of water vapour constructed by Eucken.

Kruger's theory can be regarded as a *modification of the Rutherford Bohr theory* or, to be more accurate, an application of it.

Kruger accepts Rutherford's theory of atoms, and regards gaseous molecules as gyroscopic in nature, meaning that molecular rotation is regarded as impossible, and molecules are only capable of carrying *out precessional vibrations.* These vibrations are regarded as being fundamentally different from the ordinary vibrations of atoms along the line forming their centres.

Considering molecular collision, Kruger postulates that the ring of rotating electrons of a Bohr atom, which serve to hold *two atoms in union*, suffers displacement in a direction perpendicular to the direction of motion, with the ultimate result that the atoms themselves describe small circular or approximately circular orbits and thus the molecule as one whole exhibits a precessional kind of motion.

Further, Kruger points out that such motion is wholly kinetic in nature, and involves two degrees of freedom. Now in the range of temperature in which the principle of equipartition is known to hold good, the energy term will be one corresponding to two degrees of freedom, and one degree $= \frac{1}{2}$ R T; therefore the energy is R.T. which *is identical with the energy which Bjerrum* postulated for diatomic molecules on the basis of molecular rotation as a whole over the same temperature region.

Kruger's theory possesses the advantage that it furnishes an explanation of the behaviour of monoatomic gases, viz., the behaviour of inert gases such as argon.

We now come to one of the most impor-ant pieces of work on the quantum theory, namely, Bohr's application of the quantum heory to the Rutherford Atom Model: and t seems necessary to give first a vague out-ine of the Rutherford Bohr theory of the tom.

Briefly the theory can be described as ollows: We consider the atom as consist-ng of a nuclear charge surrounded by a eries of electrons rotating in definite orbits, early the whole mass being ascribed to the ucleus. The nucleus is very small in it-elf as compared with the whole volume of he atom. The outer row of electrons are hose which gave the atom its characteris-ic chemical properties, such as valency, tc. The electrons on Rutherford's atom re regarded as "atmosphere" electrons. he above is a rough postulation of the utherford atom as conceived by its inven-or in 1911.

Bohr pointed out that the above atom uffered from the drawback of a system of atmosphere" electrons, a system unstable rom the point of view of classical electro-ynamics, but if Planck's conception was troduced the trouble vanished, instability o longer would exist from the theoretical oint of view.

Rutherford considered the hydrogen atom s follows: as consisting of a nucleus with single electron describing a closed orbit round it. Bohr considers while the elec-ron is in a steady state of rotating motion n the aforesaid orbit, it is neither radiating or absorbing energy. Radiation he con-ders to be the result of electron transfer-nce from one orbit to another. The quan-um theory assumes that during the pas-age of the electron from one stable orbit o another homogeneous radiation is given ut or absorbed at a definite frequency, and e amount given out or absorbed is hv, here h is Planck's constant.

The equations deduced from this are miliar ones, viz.:

$$W = \frac{2\pi me^2E^2}{\tau^2h^2} \qquad (1)$$

$$W = \frac{4\pi^2me^2E^2}{\tau^3h^3} \qquad (2)$$

$$2a = \frac{\tau^2h^2}{2\pi^2meE} \qquad (3)$$

where W is energy transference during change;

e is charge on the electron;
E is charge on the nucleus;
W is angular velocity;
2a major axes of orbit.

Finally one arrives at the expression:

$$v = \frac{2\pi me^4}{h^3}\left(\frac{1}{\tau_2^2} - \frac{1}{\tau_1^2}\right)$$

which gives the frequency of the homogeneous radiation emitted by a gas when the atomic system changes from a stationary state defined by τ_1 to one τ_2.

By taking the expression and putting $\tau_2 = 2$ and allowing τ_1 to vary, we get the Balmar series of lines of hydrogen spectrum. This is the most definite proof of the Bohr theory, and has therefore an effect on the corresponding quantum theory.

We have two more matters to consider briefly with regard to the quantum hypothesis, and they are: the photo electric effect and the Nernst heat theorem, in their relation to the quantum hypothesis: these we shall deal briefly with in the respective order: Photo-electric effect and Quantum Theory; Nernst Heat Theorem and Quantum Theory.

Some forty years ago what we call the "photo electric effect" was obtained by Hallwachs, who showed a charged body exposed to ultra violet light loses its charge. In the photo-electric effect we apparently deal with two phenomena: firstly, the normal photo-electric effect, and secondly the selective photo-electric effect. The effect produced moving electrons set free at surface depends on, firstly, the number of electrons emitted in unit time, and secondly on the speed of these electrons.

One of the most striking parts of the photo-electric effect is that the speed of electrons is the same for a given frequency of light independent of the intensity of the light, and more than this, on keeping the intensity constant and varying the quality of the light the speed of the electrons increases as the frequency increases. These facts have found an explanation on the quantum theory, in which, as we have seen, we regard light as heterogeneous. Sir J. J. Thomson enunciated the view we hold of the problem roughly as follows: Radiant energy which travels out from a source with a wave is not spread uniformly over the wave front, but is concentrated on those parts of the front where the pulses travel

along the lines of force. The energy of the wave, therefore, tends to become collected into regions, these regions being portions of lines of force occupied by pulses. The distribution of energy appears to be analogous *almost to the old emission theory*, the energy being located on moving particles sparsely distributed throughout space. The energy appearing in bundles and the energy content of such bundles being constant during travelling along lines of force. Thus when light falls on a metal plate, if the distance of the source is increased, we diminish the number of bundles falling on given area, but the energy in individual units will not be diminished, but any effect which is produced will be less frequent but of the same character as before. Ladenburg recently found that the velocities of corpuscles emitted under the action of ultra violet light of varied wave lengths, *varies continuously with the frequency*, hence the velocity is *proportional* to the frequency, hence although the velocity of corpuscles is independent of the intensity *of the lights, it varies apparently in a continuous* manner with the quality of the light; this clearly renders it impossible to consider the corpuscles as being expelled by the explosion of the molecule

Einstein gave the expression:

$$Ve = \tfrac{1}{2}mv^2 = hv - hv_0$$

to the quantitative relation between the theory of quantum and the photo-electric effect where $\frac{1}{2}mv^2$ is the K.E. of an electron emitted by light of frequency, v, v_0 is the threshold frequency.

Einstein's law, which can be stated as follows. "When a photochemical reaction takes place owing to the absorption of radiation in terms of quanta, each single molecule of a photosensitive substance requiring just one quantum hv_0, in order that it may be decomposed," has been investigated by Bodenstein, who found the law to break down badly, because one quantum is apparently capable of decomposing several molecules. Baley has dealt with this problem, and his argument is essentially as follows: that in the case of a dissolved substance which reacts photochemically, less energy is required per molecule than is required for the same substance in a gaseous state, and hence Einstein's law will only hold for the gaseous state.

We now consider our last problem, namely: the relation between the Nernst Heat Theorem and the Quantum Hypothesis. The application of the quantum hypothesis to the atomic heats of bodies in a solid state lead us to expect that at low temperatures, *atomic heats would become* nearly zero. Further, if we consider chemical reaction at low temperatures, the hypothesis *of quantum lead* us to the conclusion that for low temperatures the reaction between two solids will be given by:

$$\frac{dU}{dT} = 0$$

This is in agreement with the Nernst theory, which states that:

$$\underset{T=0}{\mathrm{Lt}} \left(\frac{dA}{dT}\right) = 0$$

$$\underset{T=0}{\mathrm{Lt}} \left(\frac{dU}{dT}\right) = 0$$

The relation $\frac{dA}{dT} = 0$ is in agreement also with the Plank-Einstein hypothesis regarding energy distribution in solids, because we can say this: as molecules or atoms of a solid body at low temperature possess infinitesimally small K.E. of vibration, the mutual distance apart will only change slightly with temperature over a range of this region, and hence the mutual potential energy of the atom will be nearly constant, hence their free energy will be *constant*, and hence *mathematically* we have

$$\underset{T=0}{\mathrm{Lt}} \frac{dA}{dT} = 0.$$

In composing this article, I have followed more or less the treatment of the subject by Lewis in Vol. III. of his "System of Physical Chemistry." Space unfortunately has prevented the production of anything but the mistiest of misty outlines of the subject. Many things of importance have been no more than mentioned; many more have not even been mentioned. The mathematics I have openly shirked. The only hope which I express for the article is that it may have dispelled amongst some chemists the fear and awe which the title, "*Quantum* Theory," appears to have for many of us who are research organic chemists, and not mathematical physicists.

AMERICAN DYE PRODUCTION.

THE DEMAND FOR STANDARDISATION

Prior to the war Germany dominated the world's dye markets, producing about three-fourths of all synthetic dyes. Of the remaining fourth about one-half were made of German intermediates, and consequently the production of these dyes was dependent upon Germany. Soon after the declaration of war the supply of German dyes was cut off from the world's markets. An acute dye famine developed, threatening the activities of the vast textile and other industries dependent upon dyes for their operation. Prices increased to previously unheard of levels, and certain dyes were not to be had at any price. During and since the war the United States, the United Kingdom and France have made extensive developments in the manufacture of dyes, and have exported dyes in significant quantities since the signing of the Armistice. The complete German monopoly of the world's dye production has been broken at least temporarily, if not permanently. Extensive developments in dye manufacture in the various countries have resulted in an approximate doubling of the world's capacity to produce synthetic dyes, and sharp competition may be expected in the world's dye markets. It is already in evidence in the Far East.

The German dye industry, for instance, offers a united front to the world in a combination known as the I.G. (Interessen Gemeinschaft). It possesses the advantage of cumulated experience, lower manufacturing costs, and a unified organisation for buying and selling. The three Swiss dye manufacturers have also formed an amalgamation. China leads the world as a consumer of dyes with a consumption estimated at about 70 million lbs. per annum; the United States ranks second with an average consumption of about 55 million lbs., followed by the United Kingdom with a consumption of nearly 50 million lbs. per year. It is expected that Germany will make every endeavour to recover a part of her former trade with these three dye consuming nations. In case protective measures are retained by the new dye producing countries Germany may resort to the establishment of factories or seek affiliations, as has already been done by the Swiss manufacturers in establishing plants in both the United States and the United Kingdom.

The foregoing has been taken from an advance summary* of the Report on the annual Census of Dyes and other Synthetic Organic Chemicals recently completed by the United States Tariff Commission. The following statement of the dye industry of the United States has been extracted from the same source:—

GROWTH OF DYE PRODUCTION.

The Report shows that during the year 1922 the domestic dye and organic chemical industry made notable progress. Many products were manufactured for the first time in the United States, and there were large increases in the quantity of production, with conspicuous reductions in prices.

The domestic production of dyes during the year by 87 firms was 64,682,187 lb., an increase of 66 per cent. over that of 1921. The sales for 1922 totalled 69,107,105 lb., valued at 41,463,790 dols. The size of the industry in 1922 was in sharp contrast with that of 1914, when only seven firms manufactured a total of 6,619,729 lb., valued at 2,470,096 dols. The dye industry in that period was in no sense a self-contained one, as the dyes produced were made almost entirely of intermediates imported chiefly from Germany. The increase in production during 1922 was largely due to an expansion in general business. Beginning about June the textile and other dye-consuming industries became more active after the depression, and during the remainder of the year the demand for dyes steadily increased.

LARGE PRICE REDUCTIONS.

The average selling price of all domestic dyes for 1922 was 60 cents. per lb., compared with 83 cents in 1921 and 1 dol. 26 cents per lb. in 1917. The 1922 figures represent a 28 per cent. decline from that of 1921. There were price reductions for both the bulk colours and dyes consumed in smaller quantities. The average price of indigo in 1921 was 45 cents per lb., compared with 24 cents in 1922, a 47 per cent. decrease.

INCREASED OUTPUT OF VAT AND ALIZARIN DYES.

One of the conspicuous developments of the year was the increased production of vat and alizarin dyes. The vat colours are of great complexity and have presented serious difficulties in their commercial production. Their use is on the increase, as the public is beginning to recognise that

fast shades are *obtainable on cotton goods*. The alizarin dyes are of great value in wool dyeing, and the addition to this field of new dyes and the increased production of other dyes is a significant step in the development of a self-contained dye industry. The total production in 1922 of vat dyes *(not including indigo)* was 1,075,992 lb., compared with 345,152 lb. in 1921. The production of the anthraquinone dyes, which includes alizarin dyes and a large part of the vat dyes, was 1,234,963 lb.

Production of New Dyes.

Many important dyes were produced for the first time on a commercial scale in 1922. These comprise colours of great value for the dyeing of either silk, cotton, or wool, such as vat dyes, alizarin, developed cotton dyes, mordant and acid dyes. The production of these dyes has resulted only *after large expenditures on research and* most painstaking investigations. There are, however, still gaps to be filled in certain vat dyes and some of the mordant, acid and direct dyes.

Quality and Standardisation of American Dyes.

Dye for dye, with relatively few exceptions, domestic products are now found equal to pre-war German dyes. In the early stages of the United States dye industry, after the outbreak of the Great War, many dyes were lacking in uniformity of strength and quality. This condition, however, no longer prevails, as is attested to by the largest silk and woollen manufacturers and cotton printers and dyers.

Ratio of Production to Consumption.

The United States produces about 93.5 *per cent. of the dyes actually consumed in* the country. The imports of dyes in 1922 totalled 3,982,631 lb., the production was 64,632,187 lb., and the exports totalled 6,956.593 lb. Consumption is assumed to equal production, *plus* imports, *minus* exports, or 61,658,225 lb. The imports in 1922 were *6.2 per cent. of United States* production and 6.5 per cent. of consumption. In 1914 the imports were nearly 90 per cent. of consumption.

Production by Classes.

The production of dyes in 1922, grouped by classes according to their method of application on fibres, were as follows:—

	lb.
Acid	9,880,014
Basic dyes	2,937,585
Direct cotton dyes	11,931,737
Lake and spirit-soluble dyes ...	11,009,512
Mordant and chrome dyes ...	3,749,70[illegible]
Sulphur dyes	16,913,767
Vat dyes (not including indigo)	1,075,992
Indigo	15,850,752
Unclassified dyes	1,283.127

Dye Imports: Amount and Sources.

Imports of dyes into the United States last year amounted to 3,982,631 lb., valued at 5,243,258 dols., as compared with 4,252,911 lb. in 1921 and 45,950,895 lb. in 1914. Of last year's imports, 44.58 per cent. came from Germany, 43.72 per cent. from Switzerland, 5.25 per cent. from the United Kingdom, and 4.18 per cent. from Italy. The 1922 figures show a decline of dye imports from Germany, as during the previous year 48.34 per cent. and in 1920 51 per cent. came from there. Vat dyes led in quantity of imports, totalling 1,549,024 lb. (single strength); mordant and chrome dyes amounted to 716,790 lb., and direct cotton dyes to 671,621 lb.

Expenditure on Dye Research.

The United States coal-tar dye and chemical industry expended over 21 million dols. on research during the five years 1917-22. The accomplishments of that period and the progress of the dye industry may be attributed in no small part to the enormous expenditure on research. New dyes and other chemicals of great economic value have been developed, and the costs of production have been materially reduced.

Dye Exports.

The export of dyes from the United States in 1922 shows a decrease in value from the previous year from 6,270.155 dols. *in 1921 to 3,023,127 dols.* Further, the 1922 figure is a 90 per cent. decline from that of 1920, when exports reached the maximum value of 29,823,591 dols. The large export during 1920 was due to the trade boom before German dyes made their appearance in the large dye markets of the world. The official import figures of China, India, and Japan show that large quantities of German dyes were exported to these countries after 1920, and, in addition, Swiss, French, and British dyes have been notable factors in the Far Eastern markets.

Exports of dyes for the first four months of 1923 show a recovery in value and quantity. This increased demand for American dyes, largely by the Far Eastern markets, may be attributed in part to the reduced imports of German dyes on account of the occupation of the Ruhr by the French in 1923.

OTHER FINISHED COAL-TAR PRODUCTS.

The total output of dyes and other finished coal-tar chemicals in the United States in 1922 by 164 firms was 88,368,131 lb., compared with 51,457,565 lb. by 147 firms in 1921, a 72 per cent. increase. Preliminary figures of the United States Geological Survey indicate that the production of coal tar and by-products from the by-product coke industry last year was the greatest in the history of the industry. The output of by-product coke was about 28½ million tons, which exceeded the production of both beehive and by-product coke during the previous year.

CHEMICALS OF NON-COAL TAR ORIGIN.

Conspicuous progress has also been made within the past few years in the development and manufacture of synthetic organic chemicals of non-coal tar origin. The production during 1922 was 79,202,155 lb., as compared with 21,545,186 lb. in 1921.

NEED FOR STANDARDISATION.

In a Memorandum* issued by the United States Bureau of Standards on its work in connection with the standardisation of dyes it is stated that the lack of uniformity of commercial dyes in colour strength, quality and money value is well gnown to the trade. Before the war the dye industry was controlled by the German firms, who maintained a multiplicity of names, strengths, and qualities of dyes. The trade was accustomed, therefore, to dyestuffs of variable quality, so that when the field was opened to American manufacturers opportunity was presented for the wholesale adulteration of textile colouring matters by jobbers and brokers, whose profits entailed a corresponding loss to legitimate industry. The demand for standardisation has come mainly from the dyers and textile manufacturers, who believe that standardisation will remedy this objectionable condition. The situation with respect to the enforcement of the standardisation features of the Tariff Act of 1922 clearly shows that there was little or no standardisation in the past, and that it is needed now.

The standardisation of dyes is in accord with modern business practice, whereby buyer and seller have a common basis of knowledge of the products of trade. Such practice leads to more economical business and better business to legitimate industry. The manufacturer of dyes, in particular, is coming to see the advantages of standardisation. In fact, standardisation may well become a distinctive feature of the American Dye Industry.

The problem of dye standardisation is first to devise methods for:—

(1) Identification of dye species.
(2) *Determination of colour strength in* terms of pure dye content or some arbitrarily chosen standard.
(3) Determination of quality of a dye. This includes fastness tests and tests for suitability of a given product for a special use.

Then the problem is to establish standards and specifications for each dye *which will be acceptable to manufacturer and consumer.*

* *The Summary of the Report of the Tariff Commission and the Memorandum of the Bureau of Standards, which have been forwarded by H.M. Representative at Washington, may be consulted by United Kingdom firms interested on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.*

GENERAL NOTES.

SOUTH AFRICA—TAR OR TAR SUBSTITUTE.

His Majesty's Senior Trade Commissioner in South Africa (Mr. W. E. G. Wickham) reports a call for tenders for the supply of 1,800 tons of tar or tar substitute.

Applications for further particulars should be addressed to the Department of Overseas Trade, 35, Old Queen Street, Westminster, S.W.1.

MEXICO.

His Majesty's Consul-General at Mexico City (Mr. N. King) wishes to draw the attention of British traders sending catalogues to Mexico to the necessity for the payment of the recently imposed duty on such literature.

It should be noted that delivery is not permitted before this duty has been paid.

SODIUM ACETATE (COMMERCIAL) FOR AUSTRALIA.

Mr. S. W. B. McGregor, H.M. Senior Trade Commissioner in Australia, reports that the Victorian Railways Commissioners are calling for tenders to be presented before October 17, 1923, for the supply of fifteen tons of (commercial) sodium acetate.

Applications from United Kingdom firms for further particulars should be addressed to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1, quoting reference No. 12039/E.D./C.P.

CREOSOTE FOR BULGARIA.

H.M. Legation at Sofia reports that the *Bulgarian State Railways are desirous* of receiving tenders for the supply of 500 tons of creosote to the approximate value of 3,500,000 leva. A public adjudication of tenders will be held on the 28th September, 1923.

Reference No. 11456 FE/CC(2).

QUESTIONNAIRE ON FERTILISERS.

The *International Institute* of Agriculture, Rome, has issued a questionnaire on *Fertilisers*, which is *to be sent to the Governments* of all the adhering States

The Permanent Committee of the Institute is anxious that suitable measures be taken to increase the production and use of fertilisers in agriculture.

BRITISH CATALOGUES FOR CANADA.

His Majesty's Senior Trade Commissioner in Canada (Mr. R. W. Dalton) has informed the Department of Overseas Trade that there is a serious lack of British catalogues in the various Trade Commissioners' Offices in Canada. He points out that without such catalogues, it is often a difficult matter to advise firms in Canada as to possible British sources of supply, and that the necessity of referring enquiries to headquarters in London takes time, during which business that might otherwise have gone to British firms, is lost to them.

United Kingdom firms desirous of ensuring *their names being given to* suitable enquirers should forward copies of their catalogues to any, or all, of the following:—

H.M. Senior Trade Commissioner in Canada, 285, Beaver Hall Hill, Montreal.

H.M. Trade Commissioner, 24, Adelaide Street West, Toronto.

H.M. Trade Commissioner, 210, Winch *Building, Vancouver.*

The Chief Clerk, Office of H.M. Trade Commissioner, 703, Union Bank Buildings, Winnipeg.

It should be noted that Customs duty is levied on catalogues entering Canada, and firms desiring to send them by parcel post should prepay such duty. For this purpose stamps may be obtained from the office of the High Commissioner for Canada, Kinnaird House, Pall Mall East, London, S.W.1.

THE SIR JOHN CASS TECHNICAL INSTITUTE, JEWRY STREET, ALDGATE, E.C.3.

Session 1923-24.

The session 1923-24 will commence on Thursday, September 20; students will be enrolled on Monday, Tuesday and Wednesday, September 17, 18 and 19, from 6 to 8.30 p.m.

The courses of instruction at the Institute, which are held from 6 to 10 p.m., meet the requirements of those engaged in chemical, metallurgical, electrical, petroleum and the fermentation industries.

Full facilities are provided in the well-equipped laboratories of the Institute for special investigations and research. The instruction in experimental science also provides systematic courses for the examinations of London University, the City and Guilds of London Institute, and of the Institutes of Physics, Chemistry, and Brewing.

Special courses of higher technological instruction form a distinctive feature of the work of the Institute, and during the forthcoming session the following courses will be included in the syllabus:—

Brewing, Malting, Micro-Biology, Bottling and Cellar Management, Petroleum Technology, Colloids, Alternating Currents and Electrical Oscillations, Mathematical Statistics, Metallography and Pyrometry, Heat Treatment, and Mechanical Testing of Metals and Alloys, Foundry Practice, *Mining and Surveying.*

The Postmaster-General wishes to correct the widespread impression which exists that an initial charge is made for installing a telephone.

During the war a uniform surcharge of £4 on new installations was made; but this charge was abolished more than two years

ago. The present system of charging is broadly as follows: The rental is payable quarterly in advance, and the fees for calls and other services, such as telegrams dictated over subscribers' circuits, are payable quarterly in arrear. On the completion of an installation, a new subscriber pays on account of rental the proportionate amount up to the next quarter day, together with a small deposit in respect of calls to be made during the quarter. The rental includes the cost of installing the telephone, and no other preliminary charge is made on that account.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE INSTITUTE OF METALS.

SECOND AUTUMN LECTURE,

Delivered by LIEUT.-COLONEL SIR HENRY FOWLER, K.B.E., at Manchester, on Monday, September 10, 1923, on *The Use of Non-Ferrous Metals in Engineering.*

There are very many articles which every-day use has so familiarised us with that we look upon them as common-place. A little thought, however, will show that the fact that we have them available in the form we use them is the result of years of research and patient investigation. It is probable that it was some such thought as this that led the Council of the Institute of Metals to choose the subject of the autumn lecture for this year, and to place it in the hands of an engineer.

The subject itself is so extremely comprehensive that it is only in the form of a popular lecture that it could possibly be dealt with in a single address. It may be said that the use of non-ferrous metals by engineers is the ultimate object of all papers read before the Institute.

Of these metals the one which has been in longest use is copper, and it is at present the one most closely associated either by itself or alloyed with engineering work. The uses to which its comparatively simple alloys with tin and zinc can be put are endless. The next in importance is perhaps tin which, alloyed with copper, lead and antimony, give us those white metals which allow bearings to be a practical proposition.

Aluminium is one of the most interesting of the series of metals and although from an engineering standpoint it is perhaps most generally used in connection with aeronautics, recent investigations have opened up a new field for its use.

There still remain numbers of other metals which, as alloys, are helping to solve the problems which the advances in recent engineering practice bring in their train.

ANNUAL AUTUMN MEETING OF THE INSTITUTE OF METALS, HELD IN MANCHESTER, ON TUESDAY, SEPTEMBER 11, 1923.

The Cause of Red Stains on Sheet Brass, by E. A. BOLTON, M.Sc.

The author gave an account of work carried out to elucidate this problem. The various theories which have been from time to time put forward were reviewed and experiments described which bear upon these theories. Although the experiments were carried out in the laboratory, close touch was established throughout with actual works' practice. The outstanding point is that the stains actually occur through reactions of copper oxides in the scale formed during annealing and the pickling medium. Cupric oxide, contrary to the usual opinion, is shown to be as harmful as cuprous oxide.

It is shown that oxides of copper may be present from various causes, such as careless washing after the pickling operation resulting in the presence of acid and salts during the subsequent annealing, the presence of iron in the brass or upon its surface, the use of impure rolling oils, etc. It is concluded, however, that the main cause of the oxidation of the copper is the use of old-fashioned annealing furnaces in which the flames impinge directly upon the brass.

The paper concluded with an account of possible remedies for the red-stain trouble.

Brinell Hardness Numbers, by H. W. BROWNSDON, M.Sc., PH.D., F.I.C., Member of Council.

The author drew attention to the desirability of Brinell numbers for non-ferrous metals being given in figures that may be comparable.

Stereotyping, by A. H. MUNDEY and JOHN CARTLAND, M.C., M.Sc.

The authors described the process of stereotyping which is generally regarded by printers as one which is almost a trade secret. The authors point out that the process was invented by a practical metallurgist, William Ged, an Edinburgh goldsmith, in 1750.

The metallurgical trials and difficulties were briefly dealt with, and the consideration of metallurgists is invited to some of the problems involved. The authors point out with truth that the industry is much fore important than is usually understood, and they call attention to the high degree of accuracy demanded in the mechanical and metallurgical details in order to produce the results which are a commonplace to everyone.

The enormous speed and absolute reliability of production necessary in the case of newspaper work was referred to, in addition to the fact that the product of this metallurgical process—the printed page—is open to the criticism of the whole public.

Crystallisation Effect on Galvanised Iron Sheets, by J. D. Hannah, M.Sc.Tech., and E. L. Rhead, M.Sc.Tech.

Manufacturers of galvanised iron and steel goods, specially corrugated sheets in which it is desired to obtain the best appearance, have always sought to produce a zinc covered surface having large characteristic spangles. Failure to do this is a frequently recurring source of trouble and loss. The absence of, or the production of, only small spangles has been attributed to many causes. The quality of the steel, either the presence of sulphides and other non-metallic inclusions, or its condition produced by rolling and subsequent treatment, the pickling, either caused by impurities in the acid, by the occlusion of gas by the metal, the temperature of the bath, and the purity of the zinc, have all been blamed for the failures.

Messrs. Hannah and Rhead gave an account of a research to ascertain the real causes. Little assistance can be obtained from literature on the subject.

The research shows that the metal—iron or steel—has practically no influence on the result if the temperatures are satisfactorily maintained. After the conditions of good work had been established samples of both good and bad sheet from which the zinc had been stripped, gave equally good results. It was shown that pure zinc did not yield the desired large spangles, and that too high a temperature interfered by producing large quantities of a zinc iron compound which crystallised in needles on the metal and interfered with the development of the spangle. The presence of tin or aluminium—contrary to expectation and as commonly stated—did not produce the desired result, but the addition of lead di so immediately.

Judging from the known relationshi between zinc and lead, the authors argue that the separation of the impure zinc form ing the layer on the metal sheet into conj gate solutions—lead rich and zinc rich— the dipping temperature, and the meth of subsequent crystallisation were th causes of the effects obtained. That th occurred was proved by the analysis of d ferent types of spangle occurring on th same sheet, and by the observed differenc in the rate of attack of digerent spang forming the coating. The separation is tributed to the difference in the surface te sions of the two solutions. That such d ferences exist was proved by experiment.

Proof of the hypothesis is furnished the fact that Bismuth. the only comm metal that resembles lead more or less, its relations with zinc. produces simi effects. The temperature at which good sults can be obtained is limited by the te dency to form excessive amounts of t iron zinc compound previously referred and the time occupied in dipping and co ing.

Effects of Rate of Cooling on the Dens and Composition of Metals and Alloys, R. C. Reader, Ph.D., M.Sc.

This note was concerned chiefly with t rates of cooling, fast and slow, as produ by casting in chill and sand moulds. T results recorded show that the densities pure metals are not affected by the rate which they solidify, and a similar rem applies to those alloys which solidify at constant temperature. In the case, h ever, of those alloys which solidify ove range of temperature, the rate at wh they pass through this range seriously fects the density, the slower the rat solidification the lower being the dens Also when alloys which possess a l solidifying range are prepared in cylind chill moulds they are less dense in centre than at the outside. Rapid soli cation has a pronounced effect on the c position throughout the mass of those loys which solidify over a range of temp ture. When prepared in chill these al are found to be richer on the outside in component of the lower melting point richer in the centre in the component of higher melting point. Sand casting these alloys are uniform throughout. A which solidify at a constant tempera

are uniform in composition throughout, whether prepared in sand or chill moulds.

The Effect of Small Quantities of Nickel upon High-grade Bearing Metal, by A. H. MUNDEY and C. C. BISSETT, B.A., B.Sc., B.MET.

This note gave an account of a practical trial of the effect of varying small quantities of nickel upon a tough and well-reputed bearing metal.

There was chosen for test the well known alloy consisting of:

Tin 93 per cent., Antimony 3.5 per cent., Copper 3.5 per cent.

The authors state that nickel is now found to be added to some considerable extent, possibly as a means of identification, but some merit is also claimed for it.

The results of the usual physical tests are detailed. Tensile, compression and hardness tests gave no indication of improvement due to the nickel: in fact, the alloys were rather inferior when containing nickel. Running trials on the Thurston machine on strictly comparative lines showed practically no change as between nickel and non-nickel alloys.

The comparison of hardness at varying increased temperatures exhibited no improvement. Probably the most interesting feature is the structure as shown under the microscope. In the case of the alloy with no nickel the hard copper-tin constituent is very marked in its characteristic crystalline formation. The presence of nickel even in small quantities results in a great diminution of this crystalline structure, and the structure is only in a measure restored by the addition of more copper.

The authors conclude from their experiments that the beneficial results of nickel in alloys of the character employed are yet to be demonstrated.

The Measurement of the Change of Volume in Metals during Solidification, by HIKOZO ENDO.

In the casting process it is very important to know to what extent a change of volume occurs during solidification. Notwithstanding this great necessity, the literature concerning the phenomena is very scanty, because of the lack of a suitable method for arriving at an accurate determination. In 1888, Vincentini and Omodei calculated the change of volume of some fusible metals during solidification from the change of density at the melting point. The measurement of the density of different metals in the vicinity of their melting points has been the subject of inquiry by several investigators among which are to be mentioned E. Wiedemann, Paul Pascal, and Louis Hackspill. M. Toepler, who studied the change of volume by means of a dilatometer, suggested a relation of the change of volume of a metal at melting point to its atomic weight, similar to that of the atomic volume to the atomic weight. Recently K. Bornemann and F. Sauerwald also measured the density of metals at various high temperatures by means of the Archimedes principle, using a mixture of sodium and potassium chlorides as liquid.

The present investigation was started in April, 1921, and the measurement of the change of volume during solidification or melting for a number of metals having low melting points up to 1100° C. has now been finished. This paper contains the results of the measurements, and forms the first report of the results of the investigation of a long series of experiments which are to be extended to other metals having higher melting points.

The method of investigation, which was suggested by Professor K. Honda, consists in the measurement of the change of buoyancy of a metal suspended in an inactive liquid during its solidification or melting by means of a thermobalance.

CORRESPONDENCE.

THE BRAILLE AND "SERVERS OF THE BLIND" LEAGUE.

To the Editors of THE CHEMICAL NEWS.

SIR,—As the President of the Braille and "Servers of the Blind" League, may I ask the sympathy of your readers for a unique work of help?

Up to the present no provision has been made for the defective blind children—those unfortunate babies who, in addition to blindness, have some other disability, such as backward mentality, deafness, dumbness.

The Braille and "Servers of the Blind" League has undertaken to make this provision, and is establishing the Ellen Terry National Homes for Defective Blind Children, having purchased a home at Reigate, Surrey, where these little children, who are mentally and physically blind, will have the most skilful nursing and treatment, specially adapted educational facilities, and

training in trades suited to their varying capacities.

The Junior Home for children under seven is to do a splendid work, but money is badly needed to pay the mortgage and to obtain the necessary equipment. If funds are provided, the Home can be quickly enlarged to take in more than is at present possible.

Negotiations are taking place for additional homes in the north of England, but the scheme cannot be complete unless the public come to our aid.

Buildings exist in the grounds already purchased which can easily be adapted, if the money can be found for the alterations, for training defectives in light employment suited to their capacities.

The Ministry of Health gives the heartiest welcome and support to our scheme, and is most anxious that we should bring it to an early fruition so as to extend it to the care of adult defectives. In addition, local authorities and blind institutions accord warmest co-operation to our plan, which fills a long-existing need. There is a constant enquiry regarding the admission of double defectives known to them.

No more deserving charity could be found than the kindly care of these little ones—born into the world without light and without hope unless we come to their aid—doubly blind. May I ask for all who feel for these lonely babes—the parents and relatives of those children who are blessed with sight—to share in a great national thank-offering for the power to see by sending their contribution to me at the address of the Braille and "Servers of the Blind" League, 3, Upper Woburn Place, W.C.1.

Thanking you in the name of these little ones, Yours sincerely, ELLEN TERRY.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

21136—Cocksedge, H. E.—*Manufacture of sodium carbonate.* Aug. 21.

21072—Badische Anilin & Soda Fabrik.—*Manufacture of formic acid.* Aug. 20.

Specifications Published this Week.

202078—*Imison, C. S., Bligh, J. A., Wright, R. R., and Carmichael & Co., Ltd., J. F.—Furnaces producing sulphurous gases.*

... Rayner & Co. will obtain printed copies

CITY OF CARDIFF EDUCATION COMMITTEE.

THE TECHNICAL COLLEGE.

Principal — CHARLES COLES, B.Sc. (LOND.)

DEPARTMENT OF INDUSTRIAL CHEMISTRY.

Head of Department — H. W. WEBB, M.Sc., F.I.C

Session 1923-24.

(Commencing on Tuesday, 2nd October, 1923).

JOINT COURSE

(with the University College of South Wales and Monmouthshire).

COMPLETE COURSE in CHEMISTR and associated subjects is provide for those wishing to become industria chemists. The Course includes:—

Chemistry, Physics, Mathematics Chemical Engineering, Utilisation c Steam and Electrical Power, Cost Ac counting, together with a specialised prac tical training in a branch of industri chemistry chosen from the following:—

(1) Fuel.
(2) General Iron and Steel Manufactur
(3) Gas Manufacture.
(4) Foundry-work.
(5) Tin-plate manufacture.
(6) Refractories and Cement.
(7) Electro Chemistry.
(8) Brewing.
(9) Paper-making.

Examinations which are also catered f by the Course include:—

B.Sc. (Lond.) Ext.
Associate, Institute of Chemistry.
F.I.C. in Chemical Engineering.

A number of Part-time Courses are al available to cover requirements of Work Chemist, and those of various pub examinations.

OPEN SCHOLARSHIPS, coveri tuition fees and maintenance grants of £ per annum for three years, are offered competition annually, and candidates entry to the above Department are eligi to compete.

For further particulars of Full-time Part-time Courses, Entrance Examinati Scholarships, Fees, etc., apply to Principal. Forms of application for mission to the Entrance Scholarship amination, duly completed, must be ceived by the 17th September.

JOHN J. JACKSON,
Director of Education,
CITY HALL, CARDIFF.

THE CHEMICAL NEWS,

VOL. CXXVII. No. 3310.

[British Association for the Advancement of Science: Liverpool, 1923.]

THE PRESIDENTIAL ADDRESS. THE ELECTRICAL STRUCTURE OF MATTER.

By Professor Sir Ernest Rutherford, D.Sc., LL.D.; Ph.D., F.R.S.,

President of the Association.

(*Continued from Page* 165.)

We must now look back again to the earlier stages of the present epoch in order to trace the development of our ideas on the detailed structure of the atom. That electrons as such were important constituents was clear by 1900, but little real progress followed until the part played by the positive charges was made clear. New light was thrown on this subject by examining the deviation of α particles when they passed through the atoms of matter. It was found that occasionally a swift α particle was deflected from its rectilinear path through more than a right angle by an encounter with a single atom. In such a collision the laws of dynamics ordinarily apply, and the relation between the velocities of the colliding atoms before and after collision are exactly the same as if the two colliding particles are regarded as perfectly elastic spheres of minute dimensions. It must, however, be borne in mind that in these atomic collisions there is no question of mechanical impacts such as we observe with ordinary matter. The reaction between the two particles occurs through the intermediary of the powerful electric fields that surround them. Beautiful photographs illustrating the accuracy of these laws of collision between an α particle and an atom have been obtained by Messrs. Wilson, Blackett, and others, while Mr. Wilson has recently obtained many striking illustrations of collisions between two electrons. Remembering the great kinetic energy of the α particle, its deflection through a large angle in a single atomic encounter shows clearly that very intense deflecting forces exist inside the atom. It seemed clear that electric fields of the required magnitude could be obtained only if the main charge of the atom were concentrated in a minute nucleus. From this arose the conception of the nuclear atom, now so well known, in which the heart of the atom is supposed to consist of a minute but massive nucleus, carrying a positive charge of electricity, and surrounded at a distance by the requisite number of electrons to form a neutral atom.

A detailed study of the scattering of α particles at different angles, by Geiger and Marsden, showed that the results were in close accord with this theory, and that the intense electric forces near the nucleus varied according to the ordinary inverse square law. In addition, the experiments allowed us to fix an upper limit for the dimensions of the nucleus. For a heavy atom like that of gold the radius of the nucleus, if supposed to be spherical, was less than one-thousandth of the radius of the complete atom surrounded by its electrons, and certainly less than 4×10^{-12} cms. All the atoms were found to show this nuclear structure, and an approximate estimate was made of the nuclear charge of different atoms. This type of nuclear atom, based on direct experimental evidence, possesses some very simple properties. It is obvious that the number of units of resultant positive charge in the nucleus fixes the number of the outer planetary electrons in the neutral atom. In addition, since these outer electrons are in some way held in equilibrium by the attractive forces from the nucleus, and, since we are confident from general physical and chemical evidence that all atoms of any one element are identical in their external structure, it is clear that their arrangement and motion must be governed entirely by the magnitude of the nuclear charge. Since the ordinary chemical and physical properties are to be ascribed mainly to the configuration and motion of the outer electrons, it follows that the properties of an atom are defined by a whole number representing its nuclear charge. It thus becomes of great importance to determine the value of this nuclear charge for the atoms of all the elements.

Data obtained from the scattering of α particles, and also from the scattering of X-rays by light elements, indicated that the nuclear charge of an element was numerically equal to about half the atomic weight in terms of hydrogen. It was fairly clear from general evidence that the hydrogen nucleus had a charge one, and the

helium nucleus (the α particle) a charge two. At this stage another discovery of great importance provided a powerful method of attack on this problem. The investigation by Laue on the diffraction of X-rays by crystals had shown definitely that X-rays were electromagnetic waves of much shorter wave-length than light, and the experiments of Sir William Bragg and W. L. Bragg had provided simple methods for studying the spectra of a beam of X-rays. It was found that the spectrum in general shows a continuous background on which is superimposed a spectrum of bright lines. At this stage H. G. J. Moseley began a research with the intention of deciding whether the properties of an element depended on its nuclear charge rather than on its atomic weight as ordinarily supposed. For this purpose the X-ray spectra emitted by a number of elements were examined and found to be all similar in type. The frequency of a given line was found to vary very nearly as the square of a whole number which varied by unity in passing from one element to the next. Moseley identified this whole number with the atomic or ordinal number of the elements when arranged in increasing order of atomic weight, allowance being made for the known anomalies in the periodic table and for certain gaps corresponding to possible but missing elements. He concluded that the atomic number of an element was a measure of its nuclear charge, and the correctness of this deduction has been recently verified by Chadwick by direct experiments on the scattering of α particles. Moseley's discovery is of fundamental importance, for it not only fixes the number of electrons in all the atoms, but shows conclusively that the properties of an atom, as had been surmised, are determined not by its atomic weight but by its nuclear charge. A relation of unexpected simplicity is thus found to hold between the elements. No one could have anticipated that with few exceptions all atomic numbers between hydrogen 1, and uranium 92, would correspond to known elements. The great power of Moseley's law in fixing the atomic number of an element is well illustrated by the recent discovery by Coster and Hevesy in Copenhagen of the missing element of atomic number 72, which they have named "hafnium."

[illegible] the salient features of the structure [illegible] have been fixed and the number [illegible] known, the further study of [illegible] of the atom falls naturally into two great divisions: one, the arrange[ment] of the outer electrons which control the main physical and chemical propertie[s] of an element, and the other the structur[e] of the nucleus on which the mass an[d] radioactivity of the atom depends. On th[e] nuclear theory the hydrogen atom is of ex[treme] simplicity, consisting of a singl[y] charged positive nucleus with only one at[tendant] electron. The position and motio[n] of the single electron must account for th[e] complicated optical spectrum, and wha[t]ever physical and chemical properties a[re] to be attributed to the hydrogen atom. T[he] first definite attack on the problem of th[e] electronic structure of the atom was ma[de] by Niels Bohr. He saw clearly that, if th[is] simple constitution was assumed, it is i[m]possible to account for the spectrum [of] hydrogen on the classical electrical theorie[s] but that a radical departure from existi[ng] views was necessary. For this purpose [he] applied to the atom the essential ideas [of] the Quantum Theory which had been d[e]veloped by Planck for other purposes, a[nd] had been found of great service in expla[in]ing many fundamental difficulties in oth[er] branches of science. On Planck's theo[ry] radiation is emitted in definite units [or] quanta, in which the energy E of a rad[ia]tion is equal to $h\nu$ where ν is the frequen[cy] of the radiation measured by the ordin[ary] methods and h is a universal consta[nt]. This quantum of radiation is not a defin[ite] fixed unit like the atom of electricity, [but] its magnitude depends on the frequency [of] the radiation. For example, the energy [of] a quantum is small for visible light, [but] becomes large for radiation of high f[re]quency corresponding to the X-rays or th[e] rays from radium.

Time does not allow me to discuss [the] underlying meaning of the quantum the[ory] or the difficulties connected with it. C[er]tain aspects of the difficulties were [dis]cussed in the Presidential Address be[fore] this Association by Sir Oliver Lodge at B[ir]mingham in 1913. It suffices to say t[hat] this theory has proved of great value [in] several branches of science, and is s[up]ported by a large mass of direct experim[en]tal evidence.

In applying the quantum theory to [the] structure of the hydrogen atom, Bohr s[up]posed that the single electron could m[ove] in a number of stable orbits, controlled [by] the attractive force of the nucleus, with[out] losing energy by radiation. The posi[tion] and character of these orbits were def[ined] by certain quantum relations dependin[g]

one or more whole numbers. It was assumed that radiation was only emitted when the electron for some reason was transferred from one stable orbit to another of lower energy. In such a case it was supposed that a homogeneous radiation was emitted of frequency ν determined by the quantum relation $E = h\nu$, where E was the difference of the energy of the electron in the two orbits. Some of these possible orbits are circular, others elliptical, with the nucleus as a focus, while if the change of mass of the electron with velocity is taken into account the orbits, as Sommerfeld showed, depend on two quantum numbers, and are not closed, but consist of a nearly elliptical orbit slowly rotating round the nucleus. In this way it is possible not only to account for the series relations between the bright lines of the hydrogen spectrum, but also to explain the fine structure of the lines and the very complicated changes observed when the radiating atoms are exposed in a strong magnetic or electric field. Under ordinary conditions the electron in the hydrogen atom rotates in a circular orbit close to the nucleus, but if the atoms are excited by an electric discharge or other suitable method, the electron may be displaced and occupy any one of the stable positions specified by the theory. In a radiating gas giving the complete hydrogen spectrum there will be present many different kinds of hydrogen atoms, in each of which the electron describes one of the possible orbits specified by the theory. On this view it is seen that the variety of modes of vibration of the hydrogen atom is ascribed, not to complexity of the structure of the atom, but to the variety of stable orbits which an electron may occupy relative to the nucleus. This novel theory of the origin of spectra has been developed so as to apply not only to hydrogen but to all the elements, and has been instrumental in throwing a flood of light on the relations and origin of their spectra, both X-ray and optical. The information thus gained has been applied by Bohr to determine the distribution of the electrons round the nucleus of any atom. The problem is obviously much less complicated for hydrogen than for a heavy atom, where each of the large number of electrons present acts on the other, and where the orbits described are much more intricate than the orbit of the single electron in hydrogen. Notwithstanding the great difficulties of such a complicated system of electrons in motion, it has been possible to fix the quantum numbers that characterise the motion of each electron, and to form at any rate a rough idea of the character of the orbit.

These planetary electrons divide themselves up into groups, according as their orbits are characterised by one or more equal quantum numbers. Without going into detail, a few examples may be given to illustrate the conclusions which have been reached. As we have seen, the first element, hydrogen, has a nuclear charge of 1 and 1 electron; the second, helium, has a charge 2 and 2 electrons, moving in coupled orbits on the detailed nature of which there is still some uncertainty. These two electrons form a definite group, known as the K group, which is common to all the elements except hydrogen. For increasing nuclear charge the K group of electrons retain their characteristics, but move with increasing speed, and approach closer to the nucleus. As we pass from helium of atomic number 2 to neon, number 10, a new group of electrons is added consisting of two subgroups, each of four electrons, together called the L group. This L group appears in all atoms of higher atomic number, and, as in the case of the K group, the speed of motion of the electrons increases, and the size of their orbits diminishes with the atomic number. When once the L group has been completed, a new and still more complicated M group of electrons begins forming outside it, and a similar process goes on until uranium, which has the highest atomic number, is reached.

It may be of interest to try to visualise the conception of the atom we have so far reached by taking for illustration the heaviest atom, uranium. At the centre of the atom is a minute nucleus surrounded by a swirling group of 92 electrons, all in motion in definite orbits, and occupying but by no means filling a volume very large compared with that of the nucleus. Some of the electrons describe nearly circular orbits round the nucleus; others, orbits of a more elliptical shape whose axes rotate rapidly round the nucleus. The motion of the electrons in the different groups is not necessarily confined to a definite region of the atom, but the electrons of one group may penetrate deeply into the region mainly occupied by another group, thus giving a type of inter-connection or coupling between the various groups. The maximum speed of any electron depends on the closeness of the approach to the nucleus, but

the outermost electron will have a minimum speed of more than 1,000 kilometres per second, while the innermost K electrons have an average speed of more than 150,000 kilometres per second, or half the speed of light. When we visualise the extraordinary complexity of the electronic system we may be surprised that it has been possible to find any order in the apparent medley of motions.

In reaching these conclusions, which we owe largely to Professor Bohr and his co-workers, every available kind of data about the different atoms has been taken into consideration. A study of the X-ray spectra, in particular, affords information of great value as to the arrangement of the various groups in the atom, while the optical spectrum and general chemical properties are of great importance in deciding the arrangements of the superficial electrons. While the solution of the grouping of the electrons proposed by Bohr has been assisted by considerations of this kind, it is not empirical in character, but has been largely based on general theoretical considerations of the orbits of electrons that are physically possible on the generalised quantum theory. The real problem involved may be illustrated in the following way. Suppose the gold nucleus be in some way stripped of its attendant seventy-nine electrons, and that the atom is reconstituted by the successive addition of electrons one by one. According to Bohr, the atom will be reorganised in one way only, and one group after another will successively form and be filled up in the manner outlined. The nucleus atom has often been likened to a solar system where the sun corresponds to the nucleus and the planets to the electrons. The analogy, however, must not be pressed too far. Suppose, for example, we imagined that some large and swift celestial visitor traverses and escapes from our solar system without any catastrophe to itself or the planets. There will inevitably result permanent changes in the lengths of the month and year, and our system will never return to its original state. Contrast this with the effect of shooting an electron or a particle through the electronic structure of the atom. The motion of many of the electrons will be disturbed by its passage, and in special cases an electron may be removed from its orbit or hurled out of its atomic system. In a as co time another electron will fall into the lace from one of the outer groups, acant place in turn will be filled up, and so on until the atom is again r organised. In all cases the final state the electronic system is the same as in t beginning. This illustration also serves indicate the origin of the X-rays excited the atom, for these arise in the process reformation of an atom from which an ele tron has been ejected, and the radiation highest frequency arises when the electr is removed from the K group.

It is possibly too soon to express a fin opinion on the accuracy of this theo which defines the outer structure of t atom, but there can be no doubt that constitutes a great advance. Not only do it offer a general explanation of the optic and X-ray spectra of the atom, but it a counts in detail for many of the most cha acteristic features of the periodic law Mendeléef. It gives us for the first time clear idea of the reason for the appearan in the family of elements of groups of co secutive elements with similar chemic properties, such as the groups analogous the iron group and the unique group rare earths. The theory of Bohr, like a living theories, has not only correlated multitude of isolated facts known abo the atom, but has shown its power to pr dict new relations which can be verified l experiment. For example, the theory pr dicted the relations which must subsist b tween the Rydberg constants of the arc an spark spectra, and generally between a the successive optical spectra of an el ment, a prediction so strikingly confirme by Paschen's work on the spectrum o doubly ionised aluminium and Fowler work on the spectrum of trebly ionised sil con. Finally, it predicted with such grea confidence the chemical properties of th missing element, number 72, that it ga the necessary incentive for its recent di covery.

While the progress of our knowledge o the outer structure of atoms has been muc more rapid than could have been antici pated, we clearly see that only a beginnin has been made on this great problem, an that an enormous amount of work is stil required before we can hope to form an thing like a complete picture even of th outer structure of the atom. We may be confident that the main features of the structure are clear, but in a problem o such great complexity progress in detail must of necessity be difficult and slow.

We have not so far referred to the ver difficult question of the explanation on thi theory of the chemical combination of

atoms. In fact, as yet the theory has hardly concerned itself with molecular structure. On the chemical side, however, certain advances have already been made, notably by G. N. Lewis, Kossel, and Langmuir, in the interpretation of the chemical evidence by the idea of shared electrons, which play a part in the electronic structure of two combined atoms. There can be little doubt that the next decade will see an intensified attack by physicists and chemists on this very important but undoubtedly very complicated question.

Before leaving this subject, it may be of interest to refer to certain points in Bohr's theory of a more philosophical nature. It is seen that the orbits and energies of the various groups of electrons can be specified by certain quantum numbers, and the nature of the radiation associated with a change of orbit can be defined. But at the same time we cannot explain why these orbits are alone permissible under normal conditions, or understand the mechanism by which radiation is emitted. It may be quite possible to formulate accurately the energy relation of the electrons in the atom on a simple theory, and to explain in considerable detail all the properties of an atom, without any clear understanding of the underlying processes which lead to these results. It is natural to hope that with advance of knowledge we may be able to grasp the details of the process which leads to the emission of radiation, and to understand why the orbits of the electrons in the atom are defined by the quantum relations. Some, however, are inclined to take the view that in the present state of knowledge it may be quite impossible in the nature of things to form that detailed picture in space and time of successive events that we have been accustomed to consider as so important a part of a complete theory. The atom is naturally the most fundamental structure presented to us. Its properties must explain the properties of all more complicated structures, including matter in bulk, but we may not, therefore, be justified in expecting that its processes can be explained in terms of concepts derived entirely from a study of molar properties. The atomic processes involved may be so fundamental that a complete understanding may be denied us. It is early yet to be pessimistic on this question, for we may hope that our difficulties may any day be resolved by further discoveries.

We must now turn our attention to that new and comparatively unexplored territory, the nucleus of the atom. In a discussion on the structure of the nucleus, I was rash enough to say that it was a problem that might well be left to the next generation, for at that time there seemed to be few obvious methods of attack to throw light on its constitution. While much more progress has been made than appeared possible at that time, the problem of the structure of the nucleus is inherently more difficult than the allied problem already considered of the structure of the outer atom, where we have a wealth of information obtained from the study of light and X-ray spectra and from the chemical properties to test the accuracy of our theories.

In the case of the nucleus, we know its resultant charge. fixed by Moseley's law, and its mass, which is very nearly equal to the mass of the whole atom, since the mass of the planetary electrons is relatively very small and may for most purposes be neglected. We know that the nucleus is of size minute compared with that of the whole atom, and can with some confidence set a maximum limit to its size. The study of radioactive bodies has provided us with very valuable information on the structure of the nucleus, for we know that the α and β particles must be expelled from it, and there is strong evidence that the very penetrating γ rays represent modes of vibration of the electrons contained in its structure. In the long series of transformations which occur in the uranium atom, eight α particles are emitted and six electrons, and it seems clear that the uucleus of a heavy atom is built up, in part at least, of helium nuclei and electrons. It is natural to suppose that many of the ordinary stable atoms are constituted in a similar way. It is a matter of remark that no indication has been obtained that the lightest nucleus, viz., that of hydrogen, is liberated in these transformations, where the processes occurring are of so fundamental a character. At the same time, it is evident that the hydrogen nucleus must be a unit in the structure of some atoms, and this has been confirmed by direct experiment. Dr. Chadwick and I have observed that swift hydrogen nuclei are released from the elements boron, nitrogen, fluorine, sodium, aluminium, and phosphorus when they are bombarded by swift α particles, and there is little room for doubt that these hydrogen nuclei form an essential part of the nuclear structure. The

speed of ejection of these nuclei depends on the velocity of the α particle and on the element bombarded. It is of interest to note that the hydrogen nuclei are liberated in all directions, but the speed in the backward direction is always somewhat less than in the direction of the α particle. Such a result receives a simple explanation if we suppose that the hydrogen nuclei are not built into the main nucleus but exist as satellites probably in motion round a central core. There can be no doubt that bombardment by α particles has effected a veritable disintegration of the nuclei of this group of elements. It is significant that the liberation of hydrogen nuclei only occurs in elements of odd atomic number, viz., 5, 7, 9, 11, 13, 15, the elements of even number appearing quite unaffected. For a collision of an α particle to be effective, it must either pass close to the nucleus or actually penetrate its structure. The chance of this is excessively small on account of the minute size of the nucleus. For example, although each individual α particle will pass through the outer structure of more than 100,000 atoms of aluminium in its path, it is only about one α particle in a million that gets close enough to the nucleus to effect the liberation of its hydrogen satellite.

(To be continued.)

[BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—SECTIONAL TRANSACTIONS.]

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

THURSDAY, SEPTEMBER 13.

PROF. C. G. DARWIN, F.R.S.—*The Recent Work of Prof. A. H. Compton on the Scattering of X-rays.*

PROF. C. G. BARKLA, F.R.S.—*X-ray Absorption and the J Discontinuities.*

DR. W. M. SMART.—*Navigation.*

FRIDAY, SEPTEMBER 14.

SENATORE VITO VOLTERRA, FOR. MEM. R.S.—*Liquid Jets.*

PROF. R. A. MILLIKAN.—*The Penetrating Radiations from the Upper Air.*

SIR OLIVER LODGE, F.R.S.—*Matter and Radiation.*

MR. G. STEAD and MISS B. TREVELYAN.—*The Production of Triatomic Hydrogen (?).*

Hydrogen is subjected to intense electronic bombardment in a cylindrical thermionic tube with open grid and no anode. With a grid potential of 30 volts and over, a blue glow, consisting of primary and secondary hydrogen lines, is observed near the filament. The glow spreads progressively along the tube, the current increasing similarly till it suddenly falls to a small value, and the glow simultaneously runs back. A regular oscillation of the glow and current is maintained, and the pressure in the tube follows the current changes.

It appears that a polymerised modification of hydrogen is periodically formed and decomposed. If a tube surrounded by liquid air is attached no oscillation takes place, but nearly all the gas disappears rapidly. It is re-liberated on removing the liquid air, and is stable, but easily decomposed by electric discharge, showing an increase in volume in the ratio of 1.5 to 1. The decomposed gas shows bright primary and secondary spectra of hydrogen. The optimum pressure in the tube is about 0.05 mm. of mercury.

CAPT. D. BRUNT.—*Energy of the Circulation of the Atmosphere.*

MR. F. J. W. WHIPPLE.—*Notes on the Transmission of Sound through the Atmosphere.*

DR. A. T. DOODSON.—*Meteorological Effects on Sea Level and Tides.*

MR. T. SMITH.—*Apocoptic Expansions.*

PROF. H. LEVY and MR. W. H. MOORE.—*Notes on the Approximate Expression of Empirical Results.*

REV. A. L. CORTIE.—*Series in Magnetic Disturbances.*

MR. W. M. MORDEY.—*Some Recent Studies in Alternating Magnetism.* (Illustrated by Experiments and Lantern Slides).

MR. S. G. BROWN, F.R.S.—Demonstration of the *'Frenophone,' or Friction Operated Loud-Speaker.*

MONDAY, SEPTEMBER 17.

PRESIDENTIAL ADDRESS, by PROF. J. C. McLENNAN, F.R.S., on *Origin of Spectra* (an account of which will be published subsequently in *The Chemical News*).

PROF. N. BOHR.—*The Correspondence Principle.*

The quantum theory of atomic constitution rests upon the following two postulates:—

I.—Among the conceivably possible states of motion in an atomic system there exist a number of so-called "stationary states" which, in spite of the fact that the motion of the particles in these states obeys the laws of classical mechanics to a considerable extent, possess a peculiar mechanically unexplainable stability, of such a sort that every permanent change in the motion of the system must consist of a complete transition from one stationary state to another.

II.—While in contradiction to the classical electromagnetic theory no radiation takes place from the atom in the stationary states themselves, a process of transition between two stationary states can be accompanied by the emission of electromagnetic radiation, which will have the same properties as that which would be sent out according to the classical theory from an electrified particle executing a harmonic vibration with constant frequency. This frequency ν has, however, no simple relation to the motion of the particles of the atom, but is given by the quantum relation

$$h\nu = E' - E'', \qquad (1)$$

where h is Planck's constant, and E' and E'' are the values of the energy of the atom in the two stationary states that form the initial and final states of the radiation process.

It will be the purpose of these remarks to show how, notwithstanding the fundamental departure from the ideas of the classical theories of mechanics and electrodynamics involved in these postulates, it has been possible to trace a connection between the radiation emitted by an atom and the motion of the particles which exhibits a far-reaching analogy to that claimed by the classical ideas of the origin of radiation.

It was shown by examples from the investigation of the spectra of the elements and of the effects of electric and magnetic fields on spectral lines, how the correspondence principle has been supported to an extent that seems to justify us in using it as a guide also in more complicated cases, which we meet in the theory of atomic constitution, and where it has not yet been possible to fix the stationary states in an unambiguous way by use of symbols borrowed from classical mechanics.

PROF. P. EHRENFEST. — *Remarks on Quantisation.*

PROF. P. LANGEVIN.—*The Structure of Atoms and their Magnetic Properties.*

To account for magnetic properties it is assumed that each atom or molecule normally possesses a definite magnetic moment proportional to the total moment of the quantity of electron movement. This can be zero when the symmetry of the edifice is sufficient, and always becomes modified in the diamagnetic sense under the action of an external field.

The laws of quanta allow us to predict the existence of molecular magnetic moments which are integral multiples of the Bohr magneton, and they alone permit us to develop coherently an electronic theory of magnetism in the same way as they have rendered possible a theory of atomic structure and of the emission of spectra.

PROF. R. W. WOOD, FOR. MEM. R.S., and DR. A. ELLETT.—*The Effects of Weak Magnetic Fields on the Polarisation of Resonance Radiation.*

MR. I. O. GRIFFITH.—*Experiments in very High Temperatures.*

TUESDAY, SEPTEMBER 18.

Discussion on *The Spectra of the Lighter Elements.* Opener, the President, PROF. J. C. McLENNAN, F.R.S. Speakers: Prof. N. Bohr, Prof. R. A. Millikan, Prof. A. Fowler, F.R.S., and others.

DR. F. W. ASTON, F.R.S.—*Further Determinations of the Constitution of the Elements by the method of Accelerated Anode Rays.*

MR. R. W. ROBERTS.—*The Magnetic Rotary Dispersion in certain Paramagnetic Liquids.*

MR. R. ABLETT.—*The Angle of Contact —Variation with Relative Motion of Solid and Liquid.*

Report of the Seismology Committee.

SECTION B.—CHEMISTRY.

THURSDAY, SEPTEMBER 13.

JOINT DISCUSSION with Sections A and G (in rooms of Section B), on *Cohesion and Molecular Forces.* SIR WILLIAM H. BRAGG, F.R.S., DR. W. ROSENHAIN, F.R.S., DR. A. A. GRIFFITH, and other speakers.

PROF. SVEN ODEN.—*The Formation of Precipitates.*

PROF. G. S. WHITBY.—*The Nature and Significance of the Resin of Hevea Rubber.*

The resin of raw rubber, which constitutes about 3 per cent. of the material, contains liquid unsaturated acids, a new solid fatty acid (Heveïc acid), a phytosterol glucoside, a phytosterol ester, a free phytosterol, quebrachitol, and *d*-valine. The acids have a marked influence on the vulcanisation of rubber in the presence of catalysts. The introduction into the rubber of strong bases increases the rate of vulcanisation with catalysts and enhances the tensile strength of the product. This effect is not due merely or mostly to the elimination, by neutralisation, of the retarding inkuence of acids, but largely to the dispersing action on the caoutchouc of the soaps produced. The total resin-acid-content of different samples of raw rubber varies greatly. Such variation is probably an important factor in vulcanisation. The ability of organic substances to swell rubber was studied in relation to the question of the mode of occurrence of the resin constituents in latex and in rubber.

FRIDAY, SEPTEMBER 14.

PRESIDENTIAL ADDRESS, by PROF. F. G. DONNAN, F.R.S., on *The Physical Chemistry of Interfaces* (an account of which will be published later in *The Chemical News*).

PROF. G. N. LEWIS.—*The Quantum Theory in Chemistry.*

SIR DR. N. V. SIDGWICK, F.R.S.—*The Bohr Radiation and the Periodic Law.*

DR. D. COSTER.—*On High Frequency Spectra and the Theory of Atomic Structure.*

Moseley showed that the characteristic X-ray spectra have a very simple structure. The square root of the frequency of a given X-ray line is a linear function of the atomic number. The great changes in physical and chemical properties, which mostly occur when proceeding from one element to the next one in the periodic table, are not expressed in the X-ray spectrum.

Recent researches have revealed that some peculiarities of the periodic table find expression in the X-ray spectrum. If we plot Moseley curves not for the lines themselves but for the spectral terms, we observe at different stages sudden changes in the slope of the curves. These irregularities correspond with regions of the periodic table where, according to Bohr, an inner group of electrons is being completed.

Recently X-ray spectroscopy has led to a confirmation of the Bohr theory. According to Bohr, the element of atomic number 72 should not belong to the rare earth metals, but must be a homologue of zirconium. This is verified by the discovery of hafnium.

MISS EDITH H. USHERWOOD.—*The Activation of Hydrogen in Organic Compounds.*

A great variety of organic chemical phenomena depend upon one and the same molecular condition. This condition is defiued in terms of molecular structure, and the result follows that tendency to undergo reactions of many different kinds is referred to certain definite and easily recognised structural features.

JOINT DISCUSSION with Section I (in the rooms of Section B), on *The Physical Chemistry of Membranes in Relation to Physiological Science.* PROF. H. E. ROAF, PROF. F. G. DONNAN, and other speakers.

DR. E. B. R. PRIDEAUX.—*Membrane Potentials considered as Diffusion Potentials.*

Through most ordinary membranes, such as parchment, a slow diffusion of electrolyte takes place, and the membrane potentials at these are not due to the impermeability, but to the selective permeability, of either anion or kation. These potentials are generally higher than the corresponding diffusion potentials, and may be considered as diffusion potentials in which

the transport numbers or the relative mobilities of one ion are modified by the membrane. A comparison of the mobility of the anion in the case of Na and K benzoates and salicylate determined by conductivity with the present measurements of diffusion potentials, viscosities, and membrane potentials, shows that the mobility of the benzoic anion has indeed been diminished by the parchment to a value which is apparently definite both for K and for Na salts. The mobility of the salicylic ion was diminished in a higher ratio.

MONDAY, SEPTEMBER 17.

DR. E. F. ARMSTRONG, F.R.S.—*Enzymes.*

Enzymes are to be regarded as colloid catalysts. It is customary to think of them as definite chemical entities, but the activity associated with them is connected with certain aggregates of groups in a very much larger molecule. Probably the enzyme, as such, is incapable of existing, and the larger molecule may well be variable in its nature. Their activity in the main is hydrolytic—that is, they activate water molecules, and in special cases they also bring about synthetic action; there is also the class of oxidising and reducing enzymes which act again in activating water so as to give oxygen to one and hydrogen to another acceptor. The study of enzymes is thus intimately bound up with that of the behaviour of water in solutions.

Enzymes are obtained from animal and vegetable tissues in a concentrated, as opposed to a purified, condition; their outstanding and indeed remarkable property is their very highly specific character. In every instance their action is restricted to one or to a few substances very closely related in structure, and there is obviously the most intimate correlation between the structure of the substrate and of the enzyme complex.

DR. K. G. FALK.—*The Relation of Certain Enzyme Actions to Tissue Differentiation and Tumour Growth.*

The comparative lipase actions on a number of different esters and protease actions on several protein preparations, of different tissues and organs of rats as well as of the Flexner-Jobling rat carcinoma, were studied. Well-defined differences in the actions were found. A number of tumours of human origin and some normal human tissues were studied similarly. A more complete study of the enzyme actions of fibromyoma of the uterus indicated in some cases enzyme actions of the growths similar to those of uterus muscle, and in some cases both types of actions present in the material obtained from different parts of the same specimen. The enzyme results corresponded to the histological examinations of the same materials.

MR. W. G. PALMER.—*Catalytic Actions in the System Copper, Copper-Oxide, Oxygen, and Gaseous Reducing Agent.*

The rate of oxidation of a copper film about $\frac{1}{1000}$ mm. in thickness can readily be found from observations on the increasing electrical resistance; similarly the rate of reduction of oxide can be followed by observing the decrease of resistance. Such a film conducts electricity normally, but is sufficiently thin for the effects of gaseous diffusion to be absent.

Mixtures of reducing gas (such as carbon monoxide or hydrogen) with oxygen, when brought into contact with copper at 250° C., oxidise the metal more rapidly than does pure oxygen. This effect is very marked even when equal volumes of reducing gas and oxygen are used. The reduction of copper oxide by carbon monoxide or by hydrogen at low temperatures takes place only in the presence of copper, and the rate of reduction is simply proportional to the amount of metal present.

When hydrogen is used for reduction the water formed acts as a "negative" catalyst, and the reduction is soon brought to a standstill unless the water is removed by exhaustion.

PROF. W. VERNADSKY.—*Alumosilicates.*

We can distinguish in alumosilicates bodies of different chemical functions:

anhydrides: Al_2SiO_5 sillimanite
$Al_2Si_2O_7$ leverrierite
$Al_2SiO_4F_2$ topaz, &c.
acids: $H_2Al_2Si_2O_8 . H_2O$—kaolinite
$H_2Al_2Si_4O_{12}$—pyrophyllite, &c.
salts: $K_2Al_2Si_6O_{16}$—orthoclase, &c.

All these bodies in the solid condition can give *addition products, e.g.*,

zoisite $3CaAl_2Si_2O_8 . Ca(OH)_2$
grossularite $CaAl_2Si_2O_8 . Ca_2SiO_4$

where the alumosilicate group dominates the properties of the compound,

the salts and their addition products can be divided into *three groups*:

1.—*Sillimanite salts*—of acid $H_2Al_2SiO_6$ and their addition products: group of *chloritoids*.

2.—*Leverrierite salts*—of acids $H_2Al_2Si_{2+n}O_{8+2}$ $n = 0, 2, 4, 6, 8$.

$K_2Al_2Si_2O_8$—phacellite

$K_2Al_2Si_4O_{12}$—leucite.

These compounds have a chromogene constitution.

3.—*Salts of polybasic acids* of anhydrides Al_2SiO_5, $Al_2Si_2O_7$, $Al_2Si_4O_9$ . . .

$Al_2SiO_{5-n}(HO)_2$

$Al_2Si_2O_{7-n}(HO)_2$

Chlorites

Mostly hydrated Mg and Fe compounds.

Dr. G. Hevesy.—*The Chemistry of Hafnium.*

Though hafnium is placed in the periodic table between zirconium and thorium, its chemical properties are not intermediate between those of zirconium and thorium, but much nearer to Zr.

While the fluorides and double fluorides of thorium are practically insoluble, the corresponding zirconium compounds, and still more the hafnium compounds, are fairly soluble in cold, very soluble in hot water. By this method zirconium can easily be separated from hafnium. The mineral is melted with KFHF, and by crystallising the potassium double fluorides the hafnium concentrates in the mother-liquor.

Hafnium oxalate is soluble in excess of oxalic acid. The oxychloride is less soluble than zirconium oxychloride. Hafnium is more basic than zirconium; accordingly the latter is more easily precipitated by ammonia, sodium thiosulphate, &c.; and while zirconium sulphate begins to decompose above 400°, the temperature at which hafnium sulphate undergoes marked decomposition lies about 100° higher. Thorium phosphate is easily dissolved by strong acids, zirconium phosphate much less, whereas hafnium phosphate is found to be still less soluble.

Zirconium extracted from different minerals always contains ½-30 per cent. hafnium. We must conclude that "zirconium," hitherto thought to be an element, is a mixture of zirconium and hafnium.

TUESDAY, SEPTEMBER 18.

Senatore Ginori Conti.—*The Utilisation of Volcanic Steam.* (With lantern Slides.)

Radiation.

Miss Elizabeth S. Semmens.—*The Biochemical Effect of Polarised Light.*

That plane polarised light has a distinct accelerating effect on the breaking up of starch grains in the presence of diastase can be shown under the microscope. At laboratory temperatures below 20° and with small concentration of diastase, starch grains exposed to light polarised by reflection or by a Nicol prism erode quickly and give crystals of sugar, controls in ordinary light or in the dark remaining almost intact.

Dr. R. G. Fargher.—*Cotton Wax.*

The term "cotton wax" has been applied by different writers to the extracts obtained from cotton by means of organic solvents, and even to the material removed by boiling the cotton with dilute sodium hydroxide. It includes fat, wax, and the more readily soluble portion of the resin present in the cotton, the proportion of fat being relatively small.

Comparison of the extracts obtained with a number of organic solvents indicated that carbon tetrachloride removed the fat and wax and left the major portion of the resin undissolved; whilst chloroform dissolved fat, wax and resin.

Dr. D. A. Clibbens.—*The Absorption of Methylene Blue by Cotton.*

A quantitative investigation of the conditions which determine the absorption of methylene blue by bleached cotton from neutral solutions of methylene blue hydrochloride. The object of the work was to provide a method for determining the efficiency of cotton-bleaching processes with respect to their production of pure cotton cellulose. Measurements of the absorption of methylene blue at various stages of a bleaching process show:—

The absorption by raw cotton is high, and is a property of certain acidic non-cellulose impurities.

The absorption diminishes progressively, and measures the progressihe purification of the cotton cellulose.

The absorption by scoured cotton is not further affected by normal bleaching, agents, so-called "over-bleaching," causes chemical attack of the cellulose itself and though excessive treatment with oxidising results in an increased absorption of the basic dye due to the presence of acidic oxidation products ("oxycellulose").

PROF. H. E. FIERZ.—*The Sulphonation and Nitration of Naphthalene.*

The author has investigated the interaction of naphthalene and sulphuric acid, and has been able to show that the rule established first by Armstrong and Wynne holds good in every case where the system naphthalene and sulphuric acid is involved.

Several free naphthalene-mono and di-sulphonic acids and nitration products have been prepared and described. The crystals were measured and compared with the corresponding metal salts. Over 100 were investigated.

GENERAL NOTES.

PRODUCTION OF METALS OF THE PLATINUM GROUP IN CANADA.

The High Commissioner for Canada in London has just received from the Dominion Bureau of Statistics at Ottawa, revised statistics dated July 23, on the production of metals on the platinum group in Canada.

The production of metals of the platinum group in Canada for 1922 was derived almost entirely from the nickel-copper ores of the Sudbury district. In accordance with the low production of nickel-copper, the amounts of metals of the platinum group recovered were comparatively small. The actual production figures have been augmented by the addition of quantities produced prior to 1922, hut reported for the first time in that year.

The production was valued at the average New York quotations for the year, which were as follows: platinum $97.618 per fine ounce, palladium $65.00 per fine ounce, and osmium group $80.00 per fine ounce.

GYPSUM.

The Dominion Bureau of Statistics, Canada, issues the finally revised statistics on the production of gypsum in Canada during 1922.

The total output of gypsum rock in Canada during 1922 amounted to 484,629 tons, of which quantity 145,954 tons, or 30 per cent., was calcined. The quantity quarried by provinces was: Nova Scotia, 281,861 tons; New Brunswick, 56,692 tons; Ontario, 106,829 tons; Manitoba, 39,147 tons; and Britisb Columbia, 100 tons.

For statistical purposes the production of gypsum is considered to be the sum of the quantities disposed of in the different marketable forms, care being taken to avoid duplication; the values used are those at point of shipment.

Shipments of all grades totalled 559,265 tons, valued at $2.160,898, an increase of 172,715 tons and $375,360 over the 1921 production. The 1922 production included lump or mine run, crushed, fine ground and calcined gypsum sold; calcined gypsum used in the calcining plants for the production of wall plaster, alabastine and other gypsum products was also included. The average value per ton received by operators throughout Canada was, by grades: lump, $1.52; crushed, $2.26; fine ground $6.22; and calcined, $10.67. Prices during the previous year averaged as follows: lump, $1.78; crushed, $2.56; fine ground, $3.42, and calcined, $10.61.

The Dominion Bureau of Statistics has also issued finally revised statistics on the production of salt in Canada for last year.

The output of salt from all sources in Canada during 1922 totalled 183,438 tons,

METALS OF THE PLATINUM GROUP, CANADA, 1922.

		Platinum.	Palladium.	Rhodium, Osmium, Ruthonium & Iridium.
Produced by Canadian and United States nickel refineries from Canadian ores	fine ozs.	458	724	391
	Value $	44,709	$ 47,060	$ 331,280
B.C. Placers	fine ozs.	11	...	1
	Value $	1.074	...	80
Total for Canada	fine ozs.	469 (a)	724 (b)	392 (c)
	Value $	45,783	$ 47,060	$ 31,360

(a) includes—282 ounces platinum)
(b) includes—383 ounces palladium) Produced but not reported previous to 1922.
(c) includes—266 ounces of others)

of which quantity approximately 99 per cent., or 181,794 tons, valued at $1,628,323, was marketed. Compared with the sales for the previous year, the 1922 records showed an increase of 10,811 tons, or 6.6 per cent. in quantity, and a decrease of $45,362 or 2.7 per cent. in value.

Ontario continued to be the chief producer, contributing 97.2 per cent. of the total sales. Nova Scotia shipments, from the Melagash Mine, amounted to 5,053 tons of common coarse, land and rock salt.

BRITISH MALAYA.

CONSUMPTION OF ACETIC ACID.

With the exception of native rubber holdings and possibly of one or two large estates, all rubber latex produced in British Malaya is coagulated with acetic acid. During the war, when supplies of acetic acid were difficult to obtain, sulphuric acid came into general use. This acid is cheaper than acetic, but its use has been condemned by the Department of Agriculture of the Straits Settlements and Federated Malay States, and also by the Rubber Growers' Association.

The value of acetic acid imports has risen enormously since 1920. The sources from which the acid has been imported are interesting. In 1921 Canada furnished almost 50 per cent. of the supply, but by 1923 she has altogether ceased from competition in the market. The bulk of the acid is now supplied by European Continental countries. Details as to the respective quantities exported by the different countries of the Continent in 1922 and 1923 are not yet available, but in 1921 the Netherlands and Germany were the only two European Continental countries exporting the acid to Malaya. The value of Japanese acetic acid rose enormously in 1922, but has fallen again during the first half of the current year.

BOARD OF TRADE ANNOUNCEMENT.

DYESTUFFS (IMPORT REGULATION) ACT, 1920. APPLICATIONS FOR LICENCE DURING AUGUST.

The total number of applications received during the month was 391, of which 269 were from merchants or importers. To these should be added the 29 cases outstanding on August 1, making a total for the month of 420. These were dealt with as follows:—

Granted—282 (of which 248 were dealt with within seven days of receipt).

Referred to British makers of similar products—74 (of which 63 were dealt with within seven days of receipt).

Referred to Reparation supplies available—30 (all dealt with within two days of receipt).

Outstanding on August 31—34 (mostly dealt with at the meeting of the Committee held on August 31).

Of the total of 420 applications received, 341, or 81 per cent., were dealt with within seven days of receipt.

APPEAL FOR BRITISH EMPIRE CANCER CAMPAIGN.

"HELP TO STAMP OUT CANCER!"

Following the announcement last week that the new Empire campaign against cancer was in need of voluntary workers, many offers of help have reached the headquarters of the British Red Cross Society, 19, Berkeley Street, W.1. The county branches of the Red Cross also report much enthusiasm amongst their workers who are enrolling thousands for active canvassing during the autumn campaign.

The example of Mr. Reuben Wood, of Sheffield, who recently lost his son through cancer, in collecting a sum of money for the campaign, a course he suggested to all who had lost relations or friends through this dreadful scourge, has been followed widely. Many requests have reached 19, Berkeley Street for books of stamps (of 1s. and 6d. denominations) to be sold for the benefit of the campaign, and for literature in the shape of leaflets and pamphlets describing the aims of the campaign. One enthusiastic young worker called on a recent morning at 19, Berkeley Street for a book of stamps valued at £1, and returned twice during the day for further supplies, having sold the others to his friends.

"Help to Stamp Out Cancer" is the slogan adopted for the cards of stamps which will be shortly on sale in many retail shops and other institutions. It is hoped that the purchase of these stamps, which are of a striking design and may be affixed to correspondence, will afford the public an easy and convenient way of subscribing small amounts to this great cause.

Meantime larger subscriptions continue to be made to this fund, and it is hoped that the total sum required, £1,000,000, to subsidise and initiate further research throughout the Empire will eventually be secured.

Subscriptions should be sent to the Hon. Sir Arthur Stanley, G.B.E., C.B., M.V.O., British Empire Cancer Campaign Dept., British Red Cross Society, 19, Berkeley Street, W.1, or to any of the branches of Lloyds Bank, Ltd.

PROCEEDINGS AND NOTICES OF SOCIETIES.

INSTITUTE OF METALS.

ANNUAL AUTUMN MEETING, HELD AT MANCHESTER, ON WEDNESDAY, SEPTEMBER 12.

(*Continued from Page* 175.)

The Constitution and Age-Hardening of the Quaternary Alloys of Aluminium, Copper, Magnesium and Magnesium Silicide, by MARIE L. V. GAYLER, M.Sc.

The constitution and age-hardening of the quaternary alloys of aluminium, copper, magnesium, magnesium silicide, containing up to 6 per cent. copper, 4 per cent. magnesium, and 4 per cent. magnesium silicide, were considered.

In a quaternary system it is only possible to represent the equilibrium of the system at any single temperature, and the isothermal sections take the form of regular tetrahedra. For the above investigation isotherms at 400° C. and 250° C. have been determined from the results of thermal and microscopic examination, and wire models have been constructed.

The results show that when copper, magnesium, magnesium silicide are present in aluminium, any two of these components have a marked effect on the solubility of the third. The sum of these effects is that ultimately $CuAl_2$ and Mg_2Si are both thrown out of solution. Also, if copper and magnesium are present in a ratio greater than 12 to 5 approximately, then alloys, when quenched from high temperatures, age-harden at room temperature, owing to the difference in the solubility of Mg_2Si at the quenching and ageing temperature. If, however, the ratio of copper to magnesium is less than 12 to 5, then no age-hardening takes place, since there is little difference in the solubility of Mg_2Si at high and low temperatures. The sligh increase in hardness obtained on furthe heat-treating these quenched and aged a loys is attributed to the small difference i solubility of copper at the quenching an ageing temperature. It is shown, there fore, that the age-hardening of alloys c the "Duralumin" type is due primarily t Mg_2Si, copper causing very little age hardening, and that the addition of magne sium and copper is important, since bot. reduce the solubility of Mg_2Si at high an low temperatures, and consequently reduc the maximum age-hardness due to Mg_2Si.

The Electro-Chemical Character of Corrosion, by ULICK R. EVANS, M.A.

Experiments have indicated that the corrosion of metals in mainly—probably entirey—electro-chemical in character. Corrosion accompanied by evolution of hydrogen gas is characteristic of reactive metals placed in acid solutions, but the velocity varies greatly with the purity of the metal. Where this type is impossible, slower corrosion can take place at a rate determined by the diffusion of oxygen to the metal, and comparatively independent of the purity. When a metal is immersed in a solution of potassium chloride, one can observe the production of alkali at the cathodic portions, the production of the chloride of the metal at the anodic portions, and the precipitation of hydroxide where these meet. The electric current can be trapped and measured, and is found (by applying Faraday's law) to account for the greater part of the corrosion actually observed. Generally the cathodic areas are those to which air has free access, whilst the anodic areas are those protected from aeration. It is significant that corrosion usually proceeds most rapidly at the comparatively "unaerated" places—hence the intense corrosion observed in "pits" and over areas covered up by porous corrosion-products.

Experiments with some Copper Wire; Cohesion a Function of both Temperature and Cold Work, by DOUGLAS H. INGALL, M.Sc.

Five samples of copper wire were used, representing soft annealed and four degrees of cold work given by 25, 40, 50 and 75 per cent. reduction of area by drawing. Each sample of cold worked wire was obtained by drawing in one pass from the next thicker wire. The cohesion at elevated temperatures was determined by placing given loads

on the wire at atmospheric temperature, heating the yire and determining the temperature at which it broke. All the samples gave similar graphs (plotting cohesion against temperature) in which with rise of temperature the cohesion decreased along a straight line to a constant critical temperature of 350° C., beyond which the cohesion was represented by a sharply descending curve.

Investigation of the Effects of Impurities on Copper. Part I.: The Effect of Oxygen on Copper. by D. HANSON, D.Sc., C. B. MARRYAT, B.Sc., and GRACE W. FORD, B.Sc.

The effect of oxygen, up to a concentration of 0.36 per cent., on the properties of pure copper was described. The investigation deals with the casting of the metal, cold rolling, hot rolling, density of chill-castings and rolled bars, tensile tests at ordinary and at elevated temperatures, hardness tests, fatigue tests, notched-bar impact tests, electrical conductivity, microstructure of castings, and microstructures of the alloys in various conditions, and determination of the solubility of oxygen in solid copper.

The results indicate that oxygen has a relatively small effect on the properties of copper, and is neither seriously deleterious nor remarkably beneficial. The mechanical properties are not much affected by small quantities of oxygen, and copper containing as much as 0.1 per cent. differs very slightly from pure copper. The electrical conductivity, which is usually profoundly affected by the addition of small quantities of an impurity to a pure metal, does not fall rapidly, and values exceeding 100 per cent. of the International Standard are obtained in all annealed materials containing less than 0.1 per cent. of oxygen. The relatively small effect of oxygen is without doubt due to the fact that the solubility of the oxide in solid copper is extremely low, so low in fact that for all practical purposes oxygen may be regarded as insoluble in solid copper. The oxygen-bearing metals must, therefore, be considered as a heterogeneous mixture of pure copper and finely divided particles of cuprous oxide, and within the range of composition investigated the percentage of copper greatly exceeds that of cuprous oxide. The materials consist essentially of a soft ductile copper atrix, in which harder particles of cuprous are distributed, and the properties of ... as would be expected from a mechanical mixture of such constituents.

These conclusions, however, are applicable strictly only to pure copper containing oxygen and free from other impurities. The effect of the simultaneous presence of other impurities may be very appreciable, and requires special investigation, for which the present Report furnishes a necessary basis.

Hardness Tests on Crystals of Aluminium, by HUGH O'NEILL, M.MET.

In the Brinell hardness test the relation between the applied load (L) and the diameter (d) of the indentation produced on a specimen is given by $L = ad^n$ (Mayer's formula). Many workers have determined the values of *a* and *n* for different metals, and the author has recently shown that for an amorphous substance $n = 2.0$. The present work deals with completely crystallin material, single crystals of aluminium hav ing been chosen since the technique of thei production has been worked out by Profes sor Carpenter and Miss Elam.

Two pieces of aluminium strip wer treated separately by their process, but onl the first became a single crystal. By acc dent it was annealed for a short time jus below its melting point and upon its upp surface three series of parallel ridged mar ings were visible. X-ray examinatic showed that this surface was a rhombi dodecahedral (011) face, whilst two crysta chosen from the second piece proved lik wise to be presenting octahedral (111) an cube (001) faces respectively.

Brinell tests showed that at low loa the different crystallographic planes resi penetration to different degrees, and gi indentations of different shapes. In t Brinell sense the (110) face is the "ha est" and the cube (001) face appears to the "softest." But the load required immerse the ball—and probably eventua to make it perforate the metal—is app ently the same in all cases. Crystal bou daries were also found to be without a appreciable effect in increasing the resi ance of aluminium to penetration. terms of Meyer's formula, if a 1 mm. ball used then whilst *n* varies from 2.483 for (001) face to 2.274 for the (011) face, *a* i constant for annealed aluminium. It is dependent of the presence of grain bo daries and, in single crystals, of gr orientation.

The Behaviour of Metals under Compressive Stresses, by H. I. Coe, M.Sc.

Compression tests carried out on small cylinders of metals show that with successive increments of loads plastic flow occurs, after the elastic limit has been exceeded, at an increasing rate. Graphical representation shows that at a certain load the rate of flow for a given increment of load undergoes a more or less abrupt change, very soft metals, such as tin and lead, becoming perfectly plastic, harder metals becoming more plastic than under preceding loads and immediately succeeding loads.

Annealed metals appear to commence flowing at a comparatively low load, and continue doing so at an increasing rate up to the load corresponding to critical plasticity; the same metals, however, in the worked condition are much more resistant to compressive stresses until they approach near the load corresponding to critical plasticity when they suddenly collapse and a marked temporary flow occurs.

A Dilatometric Study of the Transformations and Thermal Treatment of Light Alloys of Aluminium, by Albert M. Portevin and Pierre Chevenard.

Amongst the light alloys of aluminium capable of being hardened by quenching followed by tempering, is the group known under the name of Duralumin, whose essential characteristic is their magnesium content. The effect of the addition of this metal to aluminium was first pointed out by Wilm.

The investigations of Rosenhain, Archbutt, Hanson and Gayler have linked up the phenomena of quenching shown by these alloys, with the variation of the solubility, in solid aluminium, of Mg_2Si, which is always present in commercial aluminium. But the solubility curves of Mg_2Si, in solid aluminium, have only been indirectly traced by the examination of alloys quenched at different temperatures.

The authors conclude that (1) the application of dilatometric methods, judiciously using the recording differential dilatometer, permits of the study of the transformations and the mechanism of heat-treatment of the light alloys of aluminium-magnesium-silicon, and in general, of alloys containing two phase, univarient transformations, a study which had not been carried out up to the present. (2) The study of the constantant temperature transformations by stant temperature transformations by the differential dilatometer, using a high the differential dilatometer, using a high sensitivity apparatus, leads to general expressions representing the phenomena as functions of time and temperature. (3) The phenomena of quenching and tempering in the aluminium-magnesium-silicon alloys can be interpreted by the known variations in the solubility of Mg_2Si in the solid state, without it being necessary to assume any further transformations in these alloys.

Equilibrium in the System Gold-Zinc (based on Investigations of electrical conductivity at high temperatures), by Prof. P. Soldau.

Alloys of gold and zinc belong to the type of AR-brasses, where A is a metal belonging to the first, and R to the second group of the periodic system. These alloys are of considerable importance, as their chemical nature is very close to the alloys of copper with zinc, *i.e.*, to the ordinary brasses.

The system gold-zinc was investigated by R. Vogel in 1906, and no transformations were detected. However, the results of the investigation of the system gold-cadmium led the author to undertake the investigation of alloys of gold and zinc, taking advantage of several different methods of physico-chemical analyses, which would check and complement one another.

Special attention was paid to the determination of electrical conductivity at high temperatures, which necessitated the construction of a special apparatus.

When the results obtained by the electrical conductivity method at high temperatures and by quenching showed a complete concordance, then that former method could be recommended with sufficient guarantee for the investigation of other metallic systems, and in the first instance such practically important ones as those belonging to the type of brasses.

NOTICES OF BOOKS.

Physikalische Chemie, von Dr. Alfred Benrath. Pp. VIII. + 107. Dresden & Leipzig: Verlag von Theodor Steinkopff. 1923. Price 2s.

Prof. Benrath's concise volume aims at being a monograph on the development of physical chemistry during the last decade.

He has divided his book into two parts. The first part, entitled *Chemically pure Bodies*, is very brief, occupying only 22 pages, and being concerned with the rela-

tions between elements and compounds and the theory of allotropy. A good account of the researches of the Dutch physicists on this subject is given.

Part II. deals with *Solutions*, and commences with remarks on Van't Hoff's Theory of Solution in the case of the solution of indifferent bodies. The case of Binary Mixtures is also described.

The solution of electrolytes receives fuller treatment, commencing with a description of the theory of electrolytic dissociation. Its position in 1914 and its subsequent development are traced, and an extensive bibliography is given. The theory of indicators and of completely dissociated electrolytes are discussed. There are also sections on the electrolytic dissociation of fused and of crystallised salts.

The development of the Solvate Theory of solutions is also traced, especially in connection with the question of the existence of hydrates in aqueous solutions.

In a small volume of this kind it is essential that a selection of the literature available must be made, and this has, in the main, been done with discrimination, but references to British work later than 1914 are inadequate. This is probably not the author's intention, but is a consequence of the inability of German scientists and institutions to purchase foreign publications.

At the low price of 2s., Prof. Benrath's book, which is Vol. VIII. of the *Naturwissenschaftliche Reihe*, published under the general editorship of Prof. Liesegang, should find a wide public among chemists and physicists, and especially advanced students, for whom it is evidently intended.

Messrs. David Bridge & Co., Ltd., Castleton, Manchester, have sent a copy of *Bridge's Modern Millgearing*, pp. 132. This work, which treats the subject more deeply than is usual in catalogues, contains many illustrations, diagrams, and working formulæ, and an index. It is clearly printed on art paper, and prices for all classes of millgearing are quoted. There is also an appendix covering the field of power transmission, and should be of special interest to engineers and draughtsmen. A copy of the work may be obtained gratis on request.

BOOKS RECEIVED.

Field Crops in South Africa, by H. D. [illegible]PPAN, B.Sc.A., and G. J. BOSMAN, *Radi*[illegible] Pp. IX. + 358. 1923. Central [illegible]gency, Ltd., South Africa. 21s. net.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

202181—Coplan, A. H.—Production and refining of *nickel-chrome steels.*

Abstract Published this Week.

200175—Cleansing-compositions; sodium aluminium silicates.—Guernsey, F. H., of 7, Bewley Parkway, and Electric Smelting & Aluminium Co., both in Lockport, New York, U.S.A.

A crystalline detergent compound which is *solid at ordinary temperatures, and having the* formula Al O (SiO) x (Na O) x-1 (H O)y, where x represents any number greater than seven, is made by boiling together a mixture of aluminium silicate, sodium silicate, and caustic lye. The boiled mixture is preferably chilled to a semi-plastic condition, and allowed to solidify. When x has the value 75, the compound is completely soluble and has a melting-point of 126° F. To enhance the water-softening properties of the compound, alkali metal salts of weak acids such as *sodium or potassium carbonates*, or other carbonates, or phosphates or borates may be mixed with it. An emulsifying agent such as sulphon-*ated or saponified oils or fats may also be added,* preferably in amounts of about 5 per cent. To provide for loss of alkali oxide during cleansing operations, a further amount of oxide, up to 2 molecules for each molecule of detergent, may be *mixed with the compound.*

Latest Patent Applications.

21733—Badische Anilin & Soda-Fabrik.—Manufacture of oxygenated organic compounds. Aug. 28.

21659—Pellegrini, G.—Manufacture of meta-phenylene-diamine. Aug. 27.

21916—Pico, L.—Destructive fermentation of organic residues. Aug. 30.

22029—Scottish Dyes, Ltd.—Production of anthraquinone sulphonic acids. Aug. 31.

Specifications Published this Week.

202333—Mosicki, I.—Processes for the dry distillation of bituminous or cellulose containing material.

202383—*Air Reduction Co., Inc.—Process of* manufacture of alkali cyanides.

202,532—Germot, A.—Process for the direct obtaining of antimony.

Abstract Published this Week.

200739—*Dyes, dyeing.*—Chemische Fabrik Greisheim-Elektron, Frankfurt-on-Main, Germany.

Monoazo dyes are prepared in substance or on the fibre by coupling diazotized 5-nitro-2-toluidine with a *p*-alkyloxyarylide of 2:3-oxynaphthoic acid, the *p*-anisidide and *p*-phenetidide being mentioned; bluish-red, or in light tones, pink shades fast to light are thus obtained on the fibre; the products may also be used in the production of lakes. An example is given of the manufacture in substance of the dyestuff from 5-nitro-2-toluidine and the *p*-anisidide of 2:3-oxy-nitro-2-toluidine and the *p*-ansidide of 2:3-oxy-naphthoic acid and of the production of pink and red shades on the fibre by padding with a solution containing the *p*-anisidide, caustic soda, turkey-red oil, and formaldehyde, and developing with the diazo compound.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,

VOL. CXXVII. No. 3311.

[BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE: LIVERPOOL, 1923.]

THE PRESIDENTIAL ADDRESS. THE ELECTRICAL STRUCTURE OF MATTER.

By PROFESSOR SIR ERNEST RUTHERFORD, D.Sc., LL.D., PH.D., F.R.S.,

President of the Association.

(*Continued from Page* 182.)

This artificial disintegration of elements by α particles takes place only on a minute scale, and its observation has only been possible by the counting of individual swift hydrogen nuclei by the scintillations they produce in zinc sulphide.

These experiments suggest that the hydrogen nucleus or proton must be one of the fundamental units which build up a nucleus, and it seems highly probable that the helium nucleus is a secondary building unit composed of the very close union of four protons and two electrons. The view that the nuclei of all atoms are ultimately built up of protons of mass nearly one and of electrons has been strongly supported and extended by the study of *isotopes*. It was early observed that some of the radioactive elements which showed distinct radioactive properties were chemically so alike that it was impossible to effect their separation when mixed together. Similar elements of this kind were called ' isotopes ' by Soddy, since they appeared to occupy the same place in the periodic table. For example, a number of radioactive elements in the uranium and thorium series have been found to have physical and chemical properties identical with those of ordinary lead, but yet to have atomic weights differing from ordinary lead, and also distinctive radioactive properties. The nuclear theory of the atom offers at once a simple interpretation of the relation between isotopic elements. Since the chemical properties of an element are controlled by its nuclear charge and little influenced by its mass, isotopes must correspond to atoms with the same nuclear charge but of different nuclear mass. Such a view also offers a simple explanation why the radioactive isotopes show different radioactive properties, for it is to be anticipated that the stability of a nucleus will be much influenced by its mass and arrangement.

Our knowledge of isotopes has been widely extended in the last few years by Aston, who has devised an accurate direct method for showing the presence of isotopes in the ordinary elements. He has found that some of the elements are ' pure '—*i.e.*, consist of atoms of identical mass—while others contain a mixture of two or more isotopes. In the case of the isotopic elements, the atomic mass, as ordinarily measured by the chemist, is a mean value depending on the atomic masses of the individual isotopes and their relative abundance. These investigations have not only shown clearly that the number of distinct species of atoms is much greater than was supposed, but have brought out a relation between the elements of great interest and importance. The atomic masses of the isotopes of most of the elements examined have been found, to an accuracy of about one in a thousand, to be whole numbers in terms of oxygen, 16. This indicates that the nuclei are ultimately built up of protons of mass very nearly one and of electrons. It is natural to suppose that this building unit is the hydrogen nucleus, but that its average mass in the complex nucleus is somewhat less than its mass in the free state owing to the close packing of the charged units in the nuclear structure. We have already seen that the helium nucleus of mass 4 is probably a unit of great importance in the building up of many atoms, and it may be that other simple combinations of protons and electrons of mass 2 and 3 occur in the nucleus, but these have not been observed in the free state.

While the mass of the majority of the isotopes are nearly whole numbers, certain cases have been observed by Aston where this rule is slightly departed from. Such variations in mass may ultimately prove of great importance in throwing light on the arrangement and closeness of packing of the protons and electrons, and for this reason it is to be hoped that it may soon prove possible to compare atomic masses of the elements with much greater precision even than at present.

While we may be confident that the proton and the electron are the ultimate units which take part in the building up of all

nuclei, and can deduce with some certainty the number of protons and electrons in the nuclei of all atoms, we have little, if any, information on the distribution of these units in the atom or on the nature of the forces that hold them in equilibrium. While it is known that the law of the inverse square holds for the electrical forces some distance from the nucleus, it seems certain that this law breaks down inside the nucleus. A detailed study of the collisions between α particles and hydrogen atoms, where the nuclei approach very close to each other, shows that the forces between nuclei increase ultimately much more rapidly than is to be expected from the law of the inverse square, and it may be that new and unpected forces may come into importance at the very small distances separating the protons and electrons in the nucleus. Until we gain more information on the nature and law of variation of the forces inside the nucleus, further progress on the detailed structure of the nucleus may be difficult. At the same time, there are still a number of hopeful directions in which an attack may be made on this most difficult of problems. A detailed study of the γ rays from radioactive bodies may be expected to yield information as to the motion of the electrons inside the nucleus, and it may be, as Ellis has suggested, that quantum laws are operative inside as well as outside the nucleus. From a study of the relative proportions of the elements in the earth's crust, Harkins has shown that elements of even atomic number are much more abundant than elements of odd number, suggesting a marked difference of stability in these two classes of elements. It seems probable that any process of stellar evolution must be intimately connected with the building up of complex nuclei from simpler ones, and its study may thus be expected to throw much light on the evolution of the elements.

The nucleus of a heavy atom is undoubtedly a very complicated system, and in a sense a world of its own, little, if at all, influenced by the ordinary physical and chemical agencies at our command. When we consider the mass of a nucleus compared with its volume it seems certain that its density is many billions of times that of our heaviest element. Yet, if we could form a magnified picture of the nucleus, we should expect that it would show a discontinuous structure, occupied but not filled by the minute building units, the protons and ele trons, in ceaseless rapid motion controlle by their mutual forces.

Before leaving this subject it is desirab to say a few words on the important que tion of the energy relations involved in tl formation and disintegration of atom nuclei, first opened up by the study of radi activity. For example, it is well know that the total evolution of energy during t complete disintegration of one gramme radium is many millions of times great than in the complete combustion of an eq weight of coal. It is known that tl energy is initially mostly emitted in t kinetic form of swift α and β particles, a the energy of motion of these bodies is ul mately converted into heat when they a stopped by matter. Since is believed th the radioactive elements were analogous structure to the ordinary inactive elemer the idea naturally arose that the atoms of the elements contained a similar concent tion of energy, which would be available j use if only some simple method could be d covered of promoting and controlling th disintegration. This possibility of obta ing new and cheap sources of energy practical purposes was naturally an alluri prospect to the lay and scientific man alil It is quite true that, if we were able hasten the radioactive processes in urani and thorium so that the whole cycle of th disintegration could be confined to a f days instead of being spread over thousar of millions of years, these elements wo provide very convenient sources of ener on a sufficient scale to be of considera practical importance. Unfortunately, though many experiments have been tri there is no evidence that the rate of d integration of these elements can be alte in the slightest degree by the most powe laboratory agencies. With increase in knowledge of atomic structure there been a gradual change of our point of v on this important question, and there is no means the same certainty to-day as a cade ago that the atoms of an element tain hidden stores of energy. It may worth while to spend a few minutes discussing the reason for this change outlook. This can best be illustrated considering an interesting analogy betw the transformation of a radioactive nuc and the changes in the electron arrangen of an ordinary atom. It is now well kn

that it is possible by means of electron bombardment or by appropriate radiation to excite an atom in such a way that one of its superficial electrons is displaced from its ordinary stable position to another temporarily stable position further removed from the nucleus. This electron in course of time falls back into its old position, and its potential energy is converted into radiation in the process. There is some reason for believing that the electron has a definite average life in the displaced position, and that the chance of its return to its original position is governed by the laws of probability. In some respects an ' excited ' atom of this kind is thus analogous to a radioactive atom, but of course the energy released in the disintegration of a nucleus is of an entirely different order of magnitude from the energy released by return of the electron in the excited atom. It may be that the elements, uraninm and thorium, represent the sole survivals in the earth to-day of types of elements that were common in the long distant ages, when the atoms now composing the earth were in course of formation. A fraction of the atoms of uranium and thorium formed at that time has survived over the long interval on account of their very slow rate of transformation. It is thus possible to regard these atoms as having not yet completed the cycle of changes which the ordinary atoms have long since passed through, and that the atoms are still in the ' excited ' state where the nuclear units have not yet arranged themselves in positions of ultimate equilibrium, but still have a surplus of energy which can only be released in the form of the characteristic radiation from active matter. On such a view, the presence of a store of energy ready for release is not a property of all atoms, but only of a special class of atoms like the radioactive atoms which have not yet reached the final state for equilibrium.

It may be urged that the artificial disintegration of certain elements by bombardment with swift α particles gives definite evidence of a store of energy in some of the ordinary elements, for it is known that a few of the hydrogen nuclei, released from aluminium for example, are expelled witb such swiftness that the particle has a greater individual energy that the α particle which causes their liberation. Unfortunately, it is very difficult to give a definite answer on this point until we know more of the details of this disintegration.

On the other hand, another method of attack on this question has become important during the last few years, based on the comparison of the relative masses of the elements. This new point of view can best be illustrated by a comparison of the atomic masses of hydrogen and helium. As we have seen, it seems very probable that helium is not an ultimate unit in the structure of nuclei, but it is a very close combination of four hydrogen nuclei and two electrons. The mass of the helium nucleus, 4.00 in terms of $O = 16$, is considerably less than the mass 4.03 of four hydrogen nuclei. On modern views there is believed to be a very close connection hetween mass and energy, and this loss in mass in the synthesis of the helium nucleus from hydrogen nuclei indicates that a large amount of energy in the form of radiation has been released in the building of the helium nucleus from its components. It is easy to calculate from this loss of mass that the energy set free in forming one gramme of helium is large even compared with that liberated in the total disintegration of one gramme of radium. For example, calculation shows that the energy released in the formation of one pound of helium gas is equivalent to the energy emitted in the complete combustion of about eight thousand tons of pure carbon. It has heen suggested by Eddington and Perrin tbat it is mainly to this source of energy that we must look to maintain the heat emission of the sun and hot stars over long periods of time. Calculations of tbe loss of heat from the sun show that this synthesis of helium need only take place slowly in order to maintain the present rate of radiation for periods of the order of one thousand million years. It must be acknowledged that these arguments are somewhat speculative in character, for no certain experimental evidence has yet been obtained that helium can be formed from hydrogen.

The evidence of the slow rate of stellar evolution, however, certainly indicates that the synthesis of helium, and perhaps other elements of higher atomic weight, may take place slowly in the interior of hot stars. While in the electric discharge through hydrogen at low pressure we can easily reproduce the conditions of the interior of the hottest star as far as regards the energy of

motion of the electrons and hydrogen nuclei, we cannot hope to reproduce that enormous density of radiation which must exist in the interior of a giant star. For this and other reasons it may be very difficult, or even impossible, to produce helium from hydrogen under laboratory conditions.

If this view of the great heat emission in the formation of helium be correct, it is clear that the helium nucleus is the most stable of all nuclei, for an amount of energy corresponding to three or four α particles would be required to disrupt it into its components. In addition, since the mass of the proton in nuclei is nearly 1.000 instead of its mass 1.0072 in the free state, it follows that much more energy must be put into the atom than will be liberated by its disintegration into its ultimate units. At the same time, if we consider an atom of oxygen, which may be supposed to be built up of four helium nuclei as secondary units, the change of mass, if any, in its synthesis from already formed helium nuclei is so small that we cannot yet be certain whether there will be a gain or loss of energy by its disintegration into helium nuclei, but in any case we are certain that the magniture of the energy will be much less than for the synthesis of helium from hydrogen. Our information on this subject of energy changes in the formation or disintegration of atoms in general is as yet too uncertain and speculative to give any decided opinion on future possibilities in this direction, but I have endeavoured to outline some of the main arguments which should be taken into account.

I must now bring to an end my survey, I am afraid all too brief and inadequate, of this great period of advance in physical science. In the short time at my disposal it has been impossible for me, even if I had the knowledge, to refer to the great advances made during the period under consideration in all branches of pure and applied science. I am well aware that in some departments the progress made may justly compare with that of my own subject. In these great additions to our knowledge of the structure of matter every civilised nation has taken on active part, but we may be justly proud that this country has made many fundamental contributions. With this country I must properly include our Dominions overseas, for they have not been behindhand in their ...tributions to this new knowledge. It is, ...re, a matter of pride to this country that the scientific men of our Dominion have been responsible for some of the mos fundamental discoveries of this epoch, par ticularly in radioactivity.

This tide of advance was continuous fron 1896, but there was an inevitable slackening during the War. It is a matter of goo omen that, in the last few years, the old rat of progress has not only been maintaine but even intensified, and there appears to b no obvious sign that this period of grea advances has come to an end. There ha never been a time when the enthusiasm o the scientific workers was greater, or whe there was a more hopeful feeling that grea advances were imminent. This feeling i no doubt in part due to the great improve ment during this epoch of the technica methods of attack, for problems that at on time seemed unattackable are now seen t be likely to fall before the new methods. I the main, the epoch under consideration ha been an age of experiment, where the ex perimenter has been the pioneer in th attack on new problems. At the same time it has been also an age of bold ideas i theory, as the Quantum Theory and th Theory of Relativity so well illustrate.

I feel it is a great privilege to have wit nessed this period, which may almost b termed the Renaissance of Physics. It ha been of extarordinary intellectual interest t watch the gradual unfolding of new idea and the ever-changing methods of attack o difficult problems. It has been of grea interest, too, to note the comparative sim plicity of the ideas that has ultimatel emerged. For example, no one could hav anticipated that the the general relation b tween the elements would prove to be of s simple a character as we now believe it t be. It is an illustration of the fact th Nature appears to work in a simple wa and that the more fundamental the proble often simpler are the conceptions needed f its explanation. The rapidity and certitu of the advance in this epoch have large depended on the fact that it has been po sible to devise experiments so that few var ables were involved. For example, t study of the structure of the atom has be much facilitated by the possibility of e amining the effects due to a single atom matter, or, as in radioactivity of X-rays, studying processes going on in the ind vidual atom which were quite uninfluence by external conditions.

In watching the rapidity of this tide of adance in physics I have become more and iore impressed by the power of the ·ientific method of extending our knowdge of Nature. Experiment, directed by e disciplined imagination either of an indiidual, or still better, of a group of indiduals of varied mental outlook, is able to chieve results which far transcend the nagination alone of the greatest natural hilosopher. Experiment without imaginaon, or imagination without recourse to exeriment, can accomplish little, but, for ffective progress, a happy blend of these wo powers is necessary. The unknown ppears as a dense mist before the eyes of ien. In penetrating this obscurity we canot invoke the aid of supermen, but must epend on the combined efforts of a number f adequately trained ordinary men of cientific imagination. Each in his own pecial field of inquiry is enabled by the cientific method to penetrate a short disance, and his work reacts upon and influnces the whole body of other workers. rom time to time there arises an illuminatng conception, based on accumulated knowdge, which lights up a large region and hows the connection between these indiviual efforts, so that a general advance ollows. The attack begins anew on a ider front, and often with improved technial weapons. The conception which led to his advance often appears simple and obious when once it has been put forward. This is a common experience, and the cientific man often feels a sense of disppointment that he himself had not foreseen a development which ultimately seems o clear and inevitable.

The intellectual interest due to the rapid rowth of science to-day cannot fail to act s a stimulus to young men to join in cientific investigation. In every branch of cience there are numerous problems of ındamental interest and importance which wait solution. We may confidently preict an accelerated rate of progress of cientific discovery, beneficial to mankind ertainly in a material but possibly even iore so in an intellectual sense. In order o obtain the best results certain conditions iust, however, be fulfilled. It is necessary iat our universities and other specific institions should be liberally supported, so as ot only to be in a position to train adeuately young investigators of promise, but also to serve themselves as active centres of research. At the same time there must be a reasonable competence for those who have shown a capacity for original investigation. Not least, peace throughout the civilised world is as important for rapid scientific development as for general commercial prosperity. Indeed, science is truly international, and for progress in many directions the co-operation of nations is as essential as the co-operation of individuals. Science, no less than industry, desires a stability not yet achieved in world conditions.

There is an error far too prevalent to-day that science progresses by the demolition of former well-established theories. Such is very rarely the case. For example, it is often stated that Einstein's general theory of relativity has overthrown the work of Newton on gravitation. No statement could be farther from the truth. Their works, in fact, are hardly comparable, for they deal with different fields of thought. So far as the work of Einstein is relevant to that of Newton, it is simply a generalisation and broadening of its basis; in fact, a typical case of mathematical and physical development. In general, a great principle is not discarded but so modified that it rests on a broader and more stable basis.

It is clear that the splendid period of scientific activity which we have reviewed to-night owes much of its success and intellectual appeal to the labours of those great men in the past, who wisely laid the sure foundations on which the scientific worker builds to-day, or to quote from the words inscribed in the dome of the National Gallery, 'The works of those who have stood the test of ages have a claim to that respect and veneration to which no modern can pretend.'

[British Association, Liverpool, 1923.]

SECTION I.—PHYSIOLOGY.
SYMBIOSIS IN ANIMALS AND PLANTS.

Address by George H. F. Nuttall, M.D., Ph.D., Sc.D., F.R.S.

The address dealt with Symbiosis in Lichens, Root-nodules of Leguminous Plants, the significance of Mycorhiza in various Plants, and Symbiosis in Animals.

The term "symbiosis" denotes a condi-

tion of conjoint life existing between different organisms that in a varying degree are benefited by the partnership. The term "symbiont," strictly speaking, applies *equally to both the partners*; it has, however, come to be used also in a restricted sense as meaning the microscopic member or members of the partnership in contradistinction to the physically larger partners which are conveniently termed the "hosts" in conformity with parasitological usage.

The condition of life defined as symbiosis may be regarded as balancing between two extremes—complete immunity and deadly infective disease. A condition of perfect symbiosis or balance is realised with comparative rarity because of the many difficulties of its establishment in organisms that are either capable of living independently or are incapable of resisting the invasion of organisms imperfectly adapted to communal life. In these respects the conclusions of Bernard and Magrou in relation to plants apply equally to animals. It is difficult to imagine that symbiosis originated otherwise than through a preliminary stage of parasitism on the part of one or other of the associated organisms, the conflict between them in the course of time ending in mutual adaptation. It is, indeed, probable that some supposed symbionts may prove to be parasites on further investigation.

In perfect symbiosis the associated organisms are completely adapted to a life in common. In parasitism the degree of adaptation varies greatly; it may approach symbiotic conditions on the one hand, or range to vanishing point on the other by leading to the death of the organism that is invaded by a highly pathogenic animal or vegetable disease agent. There is no definite boundary between symbiosis and parasitism. The factors governing immunity from symbionts or parasites are essentially the same.

No final conclusions can as yet be reached regarding the function of symbionts in many invertebrate animals owing to our ignorance of the physiological processes in the associated organisms. The investigation of these problems is one fraught with difficulties which we must hope will be surmounted.

New knowledge is continually being acquired, and a glance into new and even recent publications shows that symbionts have been repeatedly seen and interpreted as mitochondria or chromidia. The increasing number of infective diseases of animals and plants, moreover, which have been traced, especially of recent years, to apparently ultramicroscopic organisms, cannot but suggest that there may exist ultramicroscopic symbionts.

We are on the threshold of further discoveries, and that a wide field of fruitful research is open to those who enter upon it. In closing, it seems but fitting to express the hope that British workers may take a more active part in the elucidation of the interesting biological problems that lie before us in the study of symbiosis and the allied subject of parasitism.

[British Association for the Advancement of Science. Liverpool, 1923.]

SECTION A.—MATHEMATICS AND PHYSICS.

ON THE ORIGIN OF SPECTRA (RECENT PROGRESS).

Address by Professor J. C. McLennan, F.R.S., President of the Section.

I.—Introduction.

The problem of the origin of spectra is intimately bound up with that of the constitution and structure of atoms. Models of atoms of different types have been proposed from time to time, and these all have served, in a measure, to explain some at least of the chemical, optical, and mechanical properties of matter. The conception, however, that inspires and co-ordinates the whole of modern atomic physics in so far as radiation is concerned is the remarkably simple atomic model of Rutherford and Bohr.

According to this model the neutral atom consists of a central positively charged nucleus with dimensions of the same order as those of the electron itself (10^{-13} cm.), and surrounded by a system of electrons whose aggregate negative charge is equal in amount to that of the positive charge carried by the nucleus. The *atomic number* gives for a neutral atom the number of electrons surrounding the nucleus, and is at the same time a measure of the positive electric charge carried by the latter.

Rutherford has shown that the electric field due to the charge on the nucleus is central, and that it follows the inverse square law practically up to the effective boundary of the nucleus. Close to the nu-

cleus the electric field is very intense, and therefore sufficient to produce those remarkably interesting deflections of alpha rays that are being studied so widely and so successfully at the present time by the use of C. T. R. Wilson's beautiful method of photographing cloud tracks.

With the introduction of the theory of *quanta* into the mechanics of the atom it became possible to analyse in detail the structure of atoms and to make quantitative comparisons between the properties of matter and those deducible from the different atomic models. In the developments that have taken place in this direction Niels Bohr has been the leader; but very notable and important contributions to the theory have been made by Wilson, Sommerfeld. Ehrenfest, Kramers, Lande, and others.

Bohr, in his theory, supposes that each electron in an atom describes a central or quasi-central orbit under the attraction of the nucleus in combination with the fields of the other extra-nuclear electrons present in the atom. He imposes, moreover, upon these motions of the electrons in atoms something in the nature of a quantum censorship.

From the continuous manifold of all conceivable states of motion that may be ascribed to an atomic system there exists a definable number of stationary states that possess a peculiar stability, and that are of such a kind that every permanent change of motion within the system must involve a complete transition from one stationary state to another.

It is postulated further that while no radiation is emitted by the atomic system when it is in one of its stationary states, the process of transition from one stationary state to another is accompanied by the emission of monochromatic radiation with a frequency given by the relation

$$\nu h = E_1 - E_2,$$

where h is Planck's constant and E_1 and E_2 are the values of the energy of the atom in the initial and final stationary states between which the transition takes place. Conversely, it is to be understood that the absorption by the atomic system of radiation with the frequency given above results in a transition back from the final stationary state to the initial one. These postulates, it will be seen, form the basis of an interpretation of the laws of series spectra, for the most general of these—the combination principle of Ritz—asserts that the frequency ν of each of the lines in the spectrum of a selected element can be represented by the formula

$$\nu = T_1 - T_2,$$

where T_1 and T_2 are two spectral terms taken from a number that are characteristic of the element in question.

On Bohr's theory the interpretation of the law of Ritz would be that the spectrum of the element referred to must originate in transitions between stationary states for which the atomic energy values are obtained simply by multiplying by Planck's constant the values of those spectral terms of which T_1 and T_2 are types.

This, it is evident, indicates the feasibility of establishing a connection between the series spectrum of an element and the constitution and structure of its atoms. From the spectrum of the element the series spectral terms can be selected and evaluated, and these values when multiplied by Planck's constant will give the various energy levels within and associated with the atom of the element. As the number of electrons within the said atom is given by the atomic number of the element, the problem becomes one of assigning to these constituent electrons orbits of a size and form that will provide the values of the energy levels determined by the spectral series terms.

The reciprocal nature of this relationship between the series spectrum of an element and its atomic structure will be evident. In a case where the series spectrum of an element is not known a knowledge of it may be obtained by determining the energy levels in the atoms of this element independently. This can be done after the manner of Moseley and Franck and Hertz by causing atoms to emit limited portions of its spectrum under bombardment by electrons of selected speeds.

STATIONARY STATES—QUANTUM CONDITIONS.

We may take the simple case of an atom of hydrogen which consists of a nucleus with charge $+e$ and an electron with charge $-e$. The frequencies of the series spectra of this element are given with great accuracy by the Balmer formula

$$\nu = K \left(\frac{1}{n''^2} - \frac{1}{n'^2} \right) \quad . \quad . \quad (1)$$

where n'' and n' are two integers and K is the Rydberg constant. All the spectral terms are of the form K/n^2, and the energy

corresponding to the various stationary states of the atom of hydrogen must be given by Kh/n^2 with n having all possible integral values.

When an electron describes an elliptic orbit about the nucleus of a hydrogen atom the major axis of the orbit described is inversely proportional to w the work required completely to remove the electron from the field of the nucleus. The major axis is given by $2a = \frac{e^2}{w}$. If, therefore, we take $2a = \frac{e^2 n}{Kh}$ we have determined for the hydrogen atom a set of clearly defined stationary states consisting of a series of elliptical orbits for which the major axis takes on discrete values proportional to the squares of the whole numbers. Transitions from one to another of such a set of stationary states will suffice on Bohr's theory to account for all the lines in the series spectrum of atomic hydrogen.

Though the single principal quantum number suffices to define the energy levels for the atom of hydrogen, the introduction of the subordinate quantum numbers n_1 and n_2 extended the basis of the theory, and, as is well known, led to developments by Sommerfeld of profound importance in dealing with the question of the fine structure of spectral lines.

Bohr's theory of the origin of spectra as it exists to-day is approached from a somewhat different angle from that given above. Through extensions initiated independently by Wilson and by Sommerfeld the quantising conditions are made to apply to momentum rather than to energy, and in dealing with the problem of the *stationary states* of a system such as that of the hydrogen atom the angular and radial momenta of the electron in its orbit are both quantised.

Quantum Numbers and Their Significance.

For a given atomic system the quantum numbers define the stationary states, and the energy values and moments of momentum of the system in these states. Moreover, they define the kinematical character of the electron orbits in the atomic edifice, and on account of the simple relation connecting the values of spectral terms in the series spectrum of an element with the energy of the atom of this element in its various stationary states, they define these spectral terms and enable us to calculate their values.

In the simplest possible treatment of a system such as that of the atom of hydrogen one quantum number n suffices to define the various factors just mentioned. In the theory of the fine structure of the spectral lines of hydrogen two quantum numbers n and k were required. In the case of a series spectrum of single lines two quantum numbers n and k are requisite to define its terms and the orbits corresponding to them. For a series spectrum consisting of doublets, triplets or multiplets, three quantum numbers are required, n, k and j to define its spectral terms and the corresponding electronic orbits. In the case of the resolution of a spectral line by the application of an external magnetic field a fourth quantum number m is necessary in order to distinguish the stationary states and toe valuate the spectral terms corresponding to the Zeeman components.

In spectroscopy it has become customary, in order to distinguish series of different kinds, to designate singlet systems by the use of capital letters, doublet series by Greek letters, and triplet series by small letters. Thus:

P S D F = singlet systems.
π σ δ ζ = doublet systems.
p s d f = triplet systems.

In the same way it has become customary to use the same letters to designate the spectral terms whose differences determine the frequencies of the lines in a series. As example we may cite 1S, 2S, &c., 1π 2π, &c.; $1d$, $2d$, &c.; and $1f$, $2f$, &c.

Principles of Selection—The Correspondence Principle.

In the early development of Bohr's theory it was found that the censorship imposed by the quantum conditions referred to above were not sufficiently drastic to account completely either for the observed complexity of the fine structure of spectral lines originating in the variation of the mass of an electron with its velocity or for the observed complexity and state of polarisation of the components of spectral lines that had their origin in the application of an external electric or magnetic field.

To make up for this deficiency arbitrary Principles of Selection, involving such factors as intensity and polarisation, were brought forward by Rubinowicz and by Sommerfeld, that found immediate and

remarkable verifications in the relativity fine structure of the Balmer lines, in the Stark effect, in the Zeeman effect, and in the spectra of rotation.

Although these principles of selection furnished rules that have served as useful guides in unravelling the intricacies of various types of spectral resolution, it has all along been recognised by the proposers, as well as by others, that the principles as formulated rested upon a dynamical basis that was rather limited and scarcely adequate.

The whole matter, however, was given an entirely new orientation and an enhanced significance by Bohr's enunciation of the Correspondence Principle.

The explicit hypothesis made by Bohr in his Correspondence Principle is that what has been shown above to be true necessarily for very great orbital periods is also sensibly true for finite ones as well. To put the matter in anothe rway—if the orbit described by an electron were carried out under a law of action proportional to the distance, the development of the law of motion in a Fourier series would permit the use of a fundamental term only. The Correspondence Principle would under these conditions demand that the electron could pass spontaneously only from the *n*th quantum orbit to the *n*—1 quantum orbit immediately below it. If these conditions were to apply in the case of the hydrogen atom, for example, it would limit each series to a single wave-length, and the Balmer series would be reduced to its first component.

The existence of series made up of numerous terms shows that the electronic orbits of an atom cannot be described under a central force varying as the direct distance, but points rather in the direction of the orbits being ellipses following approximately the Keplerian law.

In general, if the electronic motion within an atom is periodic and not simply of a pure sinusoidal character, Fourier's theory shows that the vibration of the electron is represented by a superposition of pure periodic motions that are harmonics of a fundamental one. To this classical notion therec orresponds in the theory of quanta the notion of transitions from one stationary state to another with variations in the quantum number no longer equal to one only. If the Fourier series representing the motioncon tains effectively an harmonic of rank, 1, 2, 3 . . . or *m*, for example, the Correspondence Principle postulates that the atom can be the seat of transitions corresponding to differences in the characterising quantum number of 1, 2, 3 . . . or *m*. If, on the contrary, the coefficient of a term in the Fourier series under consideration is small or equal to zero, this signifies that the probability of corresponding transitions in the atom becomes small or vanishes.

The Correspondence Principle co-ordinates every transition process between two stationary states with a corresponding harmonic vibration component in such a way that the probability of the occurrence of the transition is dependent on the amplitude of this particular vibration.

THE GENESIS OF ATOMS.

One of the more interesting of the recent developments of Bohr's theory is that which concerns the genesis of atoms of different types. Bohr has put forward the view that the fundamental process that must apply consists in the successive binding of electrons one after another by a nucleus originally naked.

On this view the electrons as they are successively bound to the nucleus take up certain final and definite orbits that are characteristic of the particular atom selected in its *normal* state, and that can to a first approximation be specified by two quantum numbers—namely, the principal and subordinate quantum numbers *n* and *k*. This means that the motion of each single electron of the atomic system can be approximately described as a plane periodic motion on which is superimposed a uniform rotation in the plane of the orbit.

It is assumed as a general postulate that during the binding of an electron by a nucleus the values of the quantum numbers *n* and *k* that characterise the orbits of the earlier bound electrons remain unchanged, and that at most, apart from a few exceptional cases, the addition of the later bound electrons merely results in slight alterations in the orientations in space of the orbits of the electrons already bound.

THE FINE STRUCTURE OF THE BALMER LINES OF HYDROGEN.

In the simplest treatment by the quantum theory of the origin of the spectrum of atomic hydrogen no allowance is made for a variation in the mass of the electron with its speed. If this factor be taken into account, as it has been by Sommerfeld, it is found that the motion of the electron is

reducible to a motion in an elliptic orbit upon which is imposed a slow rotation in its own plane about the nucleus as focus. The resulting orbit has the form of a rosette, and is similar to that shown in Fig. 5.

In this treatment the chief factor in determining the stationary states is the principal quantum number n, but the subordinate quantum number *k* is also contributory. The former practically determines the major axis and the period of the elliptical orbit, while the latter defines the parameter of the ellipse—*i.e.*, the shortest chord through its focus. The subordinate quantum number *k* also determines the period of rotation of the elliptic orbit in its plane. The energy corresponding to each stationary state is in the main determined by the value of the quantum number *n*, but stationary states determined by the same value of *n* are characterised by energy values that vary slightly with different values of the quantum number *k*.

Model of the Atom of Helium.

From the chemical point of view, helium is considered to be inert. Of all atoms it is the most stable, for it has the highest ionisation potential, namely, 24.5 volts. A study of the X-radiation emitted by the elements generally makes it appear that the configuration we assign to the electronic orbits in helium atoms is maintained intact throughout the whole of the remaining heavier elements. These orbits, as already shown, constitute for all atoms the K X-ray group the innermost and most stable system. For these reasons it is highly desirable that a model of the atom of helium be realised possessing high stability endowed with the capacity to emit radiation exhibiting the characteristic features of the helium spectrum, and having energy values for its normal and temporary stationary states that fit in with the experimentally determined values of its ionisation, resonance, and other critical excitation potentials.

The Kossel-Sommerfeld Displacement Law.

In arriving at his scheme of atomic orbits, Bohr was guided by the view that the fundamental process to keep in mind was that when a nucleus originally naked acquired electrons sufficient in number to neutralise its charge, it did so by binding them according to a programme that was definite and [illegible] for each value of the nuclear charge.

(To be continued.)

ORGANIC MERCURY COMPOUNDS.

Part I.

By R. F. Hunter, F.C.S.

Some few days ago a short review was given of our present knowledge of organic arsenic compounds, with particular reference to their immense value in dealing with protozoal diseases, mainly in reference to their use in venereal work. This leads to the consideration of organic mercury compounds owing to the fact that it has become customary in recent years to use non-ionised mercury compounds in conjunction with aromatic arsenicals, such as salvarsan. In view of this, no apology is called for in connection with this article, which is intended only as the roughest of outlines on a subject which has been attracting the attention of some of our leading researchers for many years.

The study of organic compounds of mercury carries us back to the year 1843, when A. W. von Hofmann, later professor of chemistry at the Royal College of Science, discovered a mercury compound which he prepared from aniline and mercuric chloride, and to this day the nature of the aforesaid compound, prepared as above, is a matter for discussion. Seven years later, Frankland discovered the reaction between alkyl halides and mercury. Four years after this Stricker prepared ethyl mercuric iodide.

In 1868 mercury dinaphthyl was discovered, followed the next year by Wurtz's discovery of mercury diphenyl. Subsequently Reynolds, Cahours, Meyer and Michaelis studied various compounds and preparations. 1892 saw the publication of Pesci's researches on mercury derivatives of aromatic amino compounds (aniline), researches of immense importance. In 1894 researches on the preparation of mercury derivatives of phenol and corresponding naphthalene compounds were published by Desesquelle, and three years later Bamberger discovered his reaction between N_2O_5 and the diphenyl of mercury. Dimroth the following year showed that mercuration of aromatics is a process of nitration or sulphonation.

Of more recent date, we have had such researches as Pesci's action between mercuric acetate and phthalic acid, published in 1901, the application of Grignard's reaction to organic mercury compounds by Pfeiffer 1904, the study of mercury derivatives of

nitrophenol by Hantrich in 1908. The long and academic researches of Schoeller and Schrauth started in the same year as Hantrich's results, and in 1913 the electrolysis of solutions of alkyl mercuric halides in liquid ammonia.

It will be advisable to mention the chief methods of preparation of organic mercury compounds. We can enumerate the methods by means of examples, as follows:

(a) $CH_3I + Hg \rightarrow CH_3 - Hg\ I$

$2\ CH_3\ I + 2\ Na + Hg \rightarrow CH_3\ Hg\ CH_3 + NaI$

Sodium Amalgam

$CH_3\ MgI + Hg\ I_2 \rightarrow CH_3\ HgI + MgI$

$2\ CH_3\ MgI + HgI_2 \rightarrow CH_3\ Hg\ CH_3 + 2\ MgI_2$

(b) Preparation by means of mercuric oxides, for instance, if one treats alcohol with mercuric oxide and sodium hydrate, ethane hexamer carbide, $C_2Hg_6\ O_4H_2$, is produced, in which we have hydrogen atoms of methyl groups replaced by mercury atoms. Similar compounds can be obtained from the action of mercuric oxide on aldehydes and ketones.

(c) A third method of preparation is to treat unsaturated compounds with mercuric salts in aqueous or alcoholic solution. Thus from ethylene

$$CH_2 : CH_2 + Hg\ X_2 + H_2O \rightarrow X\ Hg\ CH_2\ CH_2\ OH$$

and from acetylene

$$CH : CH \rightarrow Cl\ Hg - CH : CH\ Cl \quad (Cl\ Hg)_2\ CH.\ CH\ Cl_2 \rightarrow (Cl\ Hg)_2\ CH\ CHO \rightarrow (Cl\ Hg)_3\ C.\ CHO.$$

(d) A fruitful reaction has been that of the direct action of mercuric acetate on aromatic compounds. Thus benzene under pressure reacts in this way

$$C_6\ H_6 + Hg\ (O\ Ac)_2 \rightarrow C_6\ H_5\ Hg\ O\ Ac + H\ O\ Ac$$

Certain phenyl 5 pyrazolones have also been mercurated by this method, some three or four mercury atoms being introduced, some of which go into benzene nucleus and some of which go into the pyrazolone ring.

(e) The last reaction we shall mention is the action of mercuric chloride solution on aromatic boric and sulfinic acids, when we have, for instance:

$$C_6H_5\ B(OH)_2 + Hg\ Cl_2 + H_2O \rightarrow C_6H_5Hg\ Cl + H\ Cl + H_3\ BO_3$$

$$C_6H_5SO_2H + Hg\ Cl_2 \rightarrow C_6H_5Hg\ Cl + SO_2 + H\ Cl.$$

Before proceeding to study some of the mercury compounds, it will be advisable to pay some attention to the general properties and reactions. Whitmore, in his "Organic Compounds of Mercury," classified the reactions under the headings of

(a) Action of acids.
(b) Action of bases.
(c) Action of sulphides.
(d) Change of compounds of type R Hg X to R_2 Hg.
(e) The reverse change of R_2Hg to R Hg X.
(f) Action of halogens.
(g) Action of halides and cyanides of metals.
(h) Action of halides of non-metals.
(i) Action of alkyl and aryl halides.
(j) Action of acid halides.
(k) Action of metals.

Before proceeding to examples of these, there is one point necessary to be noted, and that is: the linkage of mercury to carbon is capable of far greater stability than that of any other metal.

For instance, a compound CH_3 Hg I, unlike the corresponding magnesium compound, is not acted upon by water, amines and alcohols. Also organic mercury halides do not react with compounds containing carbonyl. Further, the mercury in organic compounds reacts differently from ionised mercury, and the organic mercury halides can give double decomposition reactions in the same way as inorganic halides. We now consider the typical reactions under Dr. Whitmore's classification, as enumerated above:

(a) $(CH)_2\ Hg + H\ Cl = CH_3\ Hg\ Cl + CH_4$

$$(C_2H_5)_2\ Hg + CH_3\ CO_2\ H \rightarrow C_2H_6 + C_2H_5Hg\ O\ C\ O\ CH_3$$

$$C_2H_5\ Hg\ O\ CO\ CH_3 \rightarrow Hg + C_2H_5O\ C\ O\ CH_3$$

(b) Many compounds dissolve in solutions of the bases, and are recovered unchanged by allowing to cool, also bases do not normally break the carbon mercury linkage. Compounds having a free phenol or CO_2H group are soluble in bases. Many mercury compounds of these types readily yield anhydrides, or rather inner salts, which are insoluble in water. These compounds dissolve in alkalis yielding solutions of corresponding salts.

(c) The reactions of organic mercury compounds with sulphides vary greatly. Thus we may have this scheme:

$$R\ HgX \rightarrow (R\ Hg)_2\ S \rightarrow R_2Hg + Hg\ S$$

Certain compounds, such as alkyl mercuric iodide, react instantly with sulphides. It has been noticed that the compounds which react most readily are those in which the mercury atom is alpha w. carboxyl or phenyl, this giving the alpha atom its high reactivity.

The beta compounds react very slowly, if at all, and in most cases do not react at all. Thus hydroxy mercury methyl malonic ester is unacted upon by ammonium sulphide.

(d) Change from R Hg X to R Hg R.

We usually have to carry out the change in presence of a reagent; we can represent it as

$$2\ R\ Hg\ X = R_2\ Hg + Hg\ X_2.$$

The α thiophene mercuric iodides undergo the change without the addition of reagents. If we treat the chloride with NaI in the usual way, a quantity of mercury dithionyl crystallises out, and the iodide is left in the mother liquors.

The iodides which change to R_2Hg compounds on heating are α thiophene mercuric iodide and α iodo α iodo mercuric thiophene. When dealing with substituted anilides the action of an excess of alcoholic NaI is the best method for preparing R_2Hg compound, thus o. acetoxy mercuri p. bromodimethylaniline yields quantities of mercury diphenyl on refluxing some eight hours with potassium iodide or sodium iodide. A point of interest is the formation of a mercury di β phenylanhydro hydracrylic acid from anhydro α hydroxy mercuric β methoxy hydrocinnamic acid and potassium iodide.

The most general method for producing R_2Hg compound from R Hg X compounds is by the sodium thio sulphate method. The reaction has been made use of in the case of

(1) Phenyl mercury compounds.
(2) Substituted aniline and toluidine mercury compounds.
(3) Mercury compounds of diphenylamine.
(4) Phenol mercury compounds.
(5) Aminobenzoic acid mercury derivatives.
(6) Salicylic ester mercury derivatives.

Another method of obtaining the change is by means of the scheme:

$$2\ R\ Hg\ X + 2\ NaO\ H + Na_2\ Sn\ O_2 + R_2Hg \rightarrow Na_2\ Sn\ O_3 + Hg + 2\ NaX + H_2O,$$

which has been applied to such cases as ethyl mercuri chloride diepi iodhydrine dimercuric bromide. Mercurated nitro and dinitro benzoic acid, and others.

(e) Reaction hetween R_2Hg compounds and mercuric salts. The scheme is:

da $$R_2Hg + Hg\ X_2 \rightarrow 2\ R\ Hg\ X.$$

when reaction has heen carried out with electrons mpounds as
its charge, t dimethyl;
enug to a program hyl;
various 'er each valu amyl;
ohexyl·

(To be co.

Cyclomercuri pentamethylene;
Mercury diphenyl;
,, di benzyl;
,, di anilines;
,, di anisoles;
,, di phenetoles;
,, di thionyl compounds.

(f) Reaction with halogens.

The scheme is:

$$R_2\ Hg + X_2 = R\ X + R\ Hg\ X$$
$$R\ Hg\ X + X_2 = R\ X + Hg\ X_2.$$

The reaction carried out in such cases as mercury dimethyl.

Mercury di n propyl;
,, di isobutyl;
,, di isoamyl;
,, di octyl;

also with Iodomethylmercuric iodide.

Chloromethyl mercuric iodide;
Diethyl ether dimercuric iodide;
Di epi iodohydrine di mercuric iodide;
β Acetoxy mercuriethyl methyl ether.

Mercury bis mono chloroacetylene react with iodine in ethereal solution to giv chlorotri iodoethylene.

Mercury bis tri chloroethylene react with chlorine to give perchloroethane an $Hg\ Cl_2$. Anhydro hydroxy mercuri nitr acetic ester reacts with bromine to give d bromo nitro acetic ester.

Mercury diazo acetic ester with iodin gives an explosive organic compound.

The reaction has also been applied i cases of

Penta methylene di mercuric iodide;
Penta methylene di mercuri phenyl;
Tolyl mercuric chlorides;
Monomercurated phenols;
Mercurated nitro phenols;
Mercurated benzoic acid;
Mercurated Salicylic acid.

Acetoxy mercuric phenyl glycine eth ester.

Mercurated quaternary ammonium con pounds.

Mercurated anthra nilic acid and mercu dinaphthyl.

Mercurated β naphthol carboxylic aci Also mercurated camphor in benzene sol tion of iodine gives di iodo camphor, whic can be converted into a quinone of camphc

Cineol mercuric iodide reacts with iodi in ether to give a liquid iodide, which believe to be cineol iodide, but where cor position has yet to be proved.

(g) The reactions with halides and c anides of metals are indicated by tl schemes

$R\ Hg\ X + KI + H_2O \rightarrow R\ Hg + Hg\ I_2 + KOH$
$R\ C\ H\ O\ H\ CH\ (Hg\ I)\ CO_2\ K + KI$
$\rightarrow R\ CH : CH\ CO_2\ K + Hg\ I_2 + K\ O\ H,$
the reaction of iodides in formation of R_2Hg compounds having had previous treatment.

The reactions above are clearly those of Hg - C linkage splitting.

K C N has the effect of splitting many C - Hg linkages which are unaffected by K I, for instance, ethanol mercuric compounds react with K C N yielding C_2H_4 on warming.

Tetra acetoxy mercuri di acetone hydrate reacts with K CN to give acetone.

(h) The reaction with non-metallic halides is worthy of mention.

$B\ Cl_3$, for instance, reacts giving mercuri halides and compounds of type $R\ B\ Cl_2$.

$P\ Cl_3$ reacts with mercury dimethyl, yielding methyl mercuric chloride.

As Cl_3 reacts with mercury dipropyl to give tri propylarsine, thionyl chloride reacts with mercury aromatic compounds, giving corresponding aromatic mercuric chloride.

(i) The reaction with alkyl and aryl halides is not of very great importance.

Examples are:

Methylene di mercuric chloride reacts with C_2H_5I to give methyl mercuric iodide at 140°.

Mercury diphenyl heated at 200° with $C_2H_4Br_2$ gives phenyl mercuric bromide.

(j) The reaction with acid halides is likewise not very important. We might mention that mercury compounds containing amine or hydroxyl groups can be acetylated without affecting the mercury, and that the mercury addition products of ethylene compounds are capable of benzoylation.

(k) The reaction with metals is well known, for instance, sodium reacts with mercury, dimethyl and diethyl, to give corresponding sodium compounds.

The methods of preparation and the general properties and reactions of the organic mercury compounds having been given a brief review, it is proposed to now study some of the more important typical compounds in some detail, following more or less the system of Whitmore, which appears to be the best at the present time.

GENERAL NOTES.

STORES REQUIRED FOR THE NETHERLANDS COLONIAL GOVERNMENT SERVICE.

Mr. R. V. Laming, O.B.E., Commercial Secretary at The Hague, reports that the Kolonial Etablissement, 2, Westerdoksdijk, Amsterdam, is inviting tenders to be presented by 1 o'clock on September 19 for the supply and delivery of various goods, including 700 K.G. dyestuff, ultramarine; 50 K.G. dyestuff, "Kogelblauw" (wash blue); 7,000 K.G. carbonate of soda; 8,000 K.G. yellow soap.

The conditions of tenders and deliveries are contained in the "Algemeene Bepalingen betreffende de aanschaffing van goederen ten behoeve van 's Lands dienst in de Koloniën," a copy of which is in the possession of the British Chamber of Commerce for the Netherlands East Indies, Abbey House, 1, Victoria Street, London, S.W.1, who have expressed their willingness to allow interested British firms to consult it.

Copies of the specifications (in Dutch), which also contain the special conditions of tender, may be consulted by British firms on application to the Enquiry Room, Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

The possession of a representative in Holland is an essential condition of tendering, and British firms not locally represented should apply to the Department of Overseas Trade for the names of likely agents to act for them in this matter.

CZECHO-SLOVAKIA'S FOREIGN TRADE IN JULY.

The Officer in Charge for the Commercial Secretary at Prague informs the Department of Overseas Trade that, according to the official figures just published by the State Office of Statistics, the value of the Czecho-Slovak exports for July amounted to 1,008 million crowns, and the imports to 744 million crowns, thus showing a balance of 264 million crowns in favour of exports. The exports for the first seven months of this year totalled 6,621 million crowns, and the imports 4,816 millions, an excess of 1,704 million of crowns of exports over imports.

AUSTRALIA'S FOREIGN TRADE FOR THE YEAR ENDED 30 JUNE, 1923.

Mr. S. W. B. McGregor, H.M. Senior Trade Commissioner in Australia, has informed the Department of Overseas Trade that the statistics of Australian trade for the year ending 30 June, 1923, show that the imports were £131,808,673, as compared with £127,846,535 for the previous year, a decrease of £9,923.452.

The balance of trade favourable to Australia in 1921-22, amounting to £24,780,099, has become an adverse balance of £13,895,590 in 1922-23.

The accumulation of Australian funds in London, together with new loan money, has had a stimulating effect on imports and some reaction, temporarily unfavourable to British trade, must be expected.

The decrease in the value of exports in 1922-23 is largely due to the fall in the value of wheat, which accounts for £20,136,000 of the decrease as compared with 1921-22. The increase in the value of wool exported was £9,163,000.

There has been a marked increase in the value of imported manufactured apparel and in textiles generally, the total for this class being £44,914,128 compared with £34,149,710 in 1921-22. Some falling off in these lines of trade must now be anticipated.

The total value of imports of metals, metal manufactures, and machinery was £35,195,931, compared with £25,096,571 in 1921-22, of which chassis for motor cars are valued at £6,117,179, compared with £2,927,759 in the previous year. This extraordinary increase in the value of the imports of motor cars is an indication of the prosperity of Australia generally, and a growing feeling that a motor car is a necessity for the efficient conduct of town or country avocations.

Information as to countries of origin and destination of imports and exports respectively will not be available for several months.

NOTICES OF BOOKS.

[...]wood and Eastlake's Petroleum [...]nologist's Pocket-Book, Revised by [...]. EASTLAKE, M.I.MIN.E., A.M.I.[...].E. Pp. 546. Second Edition. [...]on: Charles Griffin & Co., Ltd., [...] Street, Strand, W.C.2. 1923.

The need for a small handy work of reference on petroleum has been met by the publication, in 1915, of this pocket-book. Its proved usefulness has led to the appearance of a second and revised edition by Mr. Eastlake, to which Sir Thomas H. Holland, Vice-President of the Institution of Petroleum Technologists, etc., has contributed a Foreword.

Chemists and technologists may be reminded that the volume contains much condensed information concerning the Geology, Physics, and Chemistry of Petroleum. A good deal of space is devoted to production, which is followed by a section on refining, transport, storage and testing. In addition to statistical tables, weights and measures, there is also a miscellaneous section, which gives a list of the Courses of Instruction in Petroleum Technology in various centres; an inclusive list of petroleum periodicals; Passport Regulations; Numerals, etc., in eight languages; etc.

Eight small but useful maps, indicating the sources of petroleum and other deposits, are contained in a pocket at the end.

The extent of the revision of this edition may be gauged by the fact that over 100 pages have been added, but the bulk of the book is the same, since it is printed on thinner (but very good) paper.

The book reflects credit upon all concerned with its publication, and should prove to be of especial value to petroleum technologists.

The Phase Rule and the Study of Heterogeneous Equilibria. An Introductory Study, by A. C. D. RIVETT, M.A., D.Sc. Pp. 204. Oxford: At the Clarendon Press. Price 10s. 6d. net.

The theoretical importance of the Phase Rule is not likely to be under-estimated so long as the work of Professor Ostwald is remembered. But the Phase Rule is not only important from the theoretical point of view. As Professor Rivett writes: "The study of heterogeneous equilibria, from the standpoint of the Phase Rule and the Principle of Le Chatelier and Braun, is one which every manufacturer would do well to require from his chemical staff. Whether or not costly evaporations are necessary, or recrystallisations or extractions with

solvents, only systematic work will show. The cost of such investigation will usually be slight compared with the gains that will be made possible." In view of these facts, he small number of text-books dealing with the subject of the Phase Rule that are available seems to be totally incommen-urate with the importance of the subject, and a very hearty welcome is therefore ex-ended to this introductory study by Pro-essor Rivett, which it is hoped will tend to timulate further interest therein.

The work is strictly in the nature of an ntroduction, and, as the author points out, must not be regarded as constituting either treatise or a book of reference; which act, perhaps, explains the absence of an in-ex. The author's aim has been to discuss ypes of systems which may be met, and ays in which such systems may be gra-hically represented, and to giving some xamples of the manner in which conclu-ions of practical importance may be de-uced.

The author commences his treatment of he graphical representation of various sys-ems by means of three dimensioned models, from which the more usual two di-mensioned graphs are obtained by con-idering special planes. This is, as he oints out, not the usual procedure, but, lthough students may have some little ifficulty in dealing with the three dimen-oned models, the method certainly has he advantage of being more logical than he more customary one. In fact, the logi-al quality of Dr. Rivett's treatment hroughout calls for favourable notice. In he Preface, for example, he calls attention the fact that when we are dealing with ixtures containing more than one compo-ent there cannot be equilibrium between wo phases unless each component is pre-nt in each phase. As concerns solid hases, this fact is (except in special cases) sually ignored, owing to the very small lvent power of solids. Unless, however, e formation of solid solutions is recog-sed, the subject cannot be presented in ich a way that conclusions shall strictly onform throughout to the basic principles mmarised in the Phase Rule.

In dealing with mixtures of three com-onents, considerable use is made of Gibb's uilateral triangle diagrams. There is so a long chapter dealing with four com-onent systems, and another containing me simple thermo-dynamical considera-ons relavent to the subject.

H. S. R[illegible]VE.

Rhus Dermatitis (Poison Ivy)—Its Pathology and Chemotherapy, by James B. McNair. Pp. IX. + 298. The University of Chicago Press, 5750, Ellis Avenue, Chicago, Illinois, U.S.A. $4.00 (post paid $4.15).

Of all cutaneous eruptions caused accidentally by plant substances, that resulting from the poison oak or poison ivy is the most common in North America. The lack of any rational treatment for this common poisoning has led Mr. McNair into a protracted study of the isolated principle, in the hope that knowledge of its characteristic properties may serve as a basis for such treatment.

From a general botanical description of the plants, *Rhus Toxicodendron*, *R. radicans*, and especially *R. diversiloba*, which have long been known under the names of poison ivy or poison oak, it is shown that the fresh sap emulsion from the resin canals alone is dangerous. All other parts of the plant have been shown to be non-toxic. The poisonous properties also decrease as the fruit ripens.

The author has traced the chemical investigations into the nature of the poisonous principle — lobinol — which has been shown to contain only carbon, hydrogen, and oxygen, and which is a phenolic compound. An exact knowledge of its chemical nature is of supreme importance if a rational remedy for its action is to be sought. The substance was originally regarded as a volatile alkaloid, and later as an acid until the absence of any carboxyl group was proved. Consequently the early remedies adopted were quite empirical.

The volume contains much interesting matter relating to pathological cases, immunity, and the chemo-therapy of the subject, and concludes with a comprehensive bibliography of botanical, chemical and pathological references.

We have received a copy of the *Announcements* of the Northampton Polytechnic Institute, giving particulars of the courses of instruction in the different branches of Scientific and Engineering Industries.

On this occasion the new issue deals with the *evening* work only. The well-known work dealt with in the day section of the *Announcements* will be practically the same as last session, there being only small changes in details of syllabuses which can be made as the work develops.

The whole of the work includes day and ·ening courses in Engineering (Civil, ·echanical and Electrical), in Optical Enneering and Applied Optics, and in Horogy. The Engineering courses include b-sections in Automobile work, Aeronau·s, and Radio-Telegraphy. In addition ere are evening courses in Electroıemistry, Metallurgy, and Domestic Ecoımy and Women's Trades. The classes r the day courses commence on Monday, ɔtober 1, and those for the evening ·urses on Monday, September 24. Enrolents for the latter commenced on Monty, the 17th inst.

Full details of the syllabuses and the ɥuipment are also given.

PUBLICATIONS RECEIVED.

The U.S. Department of the Interior, ureau of Mines, has just issued the fol·wing pamphlets:

Explosives—Their Materials, Constituon and Analysis, by C. A. TAYLOR and ʋM. H. RINKENBACH. Pp. XI. + 188.

Progress of Investigations on Liquidxygen Explosives, by S. P. HOWELL, J. ʋ. PAUL and J. L. SHERRICK. Pp. VII. + 1.

Anhydrous Aluminium Chloride, by OLIER C. RALSTON. Pp. IV. + 38.

Fires in Steamship Bunker and Cargo ·oal, by H. H. STOEK. Pp. IV. + 51.

The Motor Gasoline Surveys of 1920 and 921 (A sequel to Bulletin 191), by N. A. ·. SMITH. Pp. 41.

Mine Rescue Standards—A Tentative Study, prepared by a Committee appointed t the International Mine Rescue Standrdisation Conference, September, 1921. ·p. IV. + 43.

Permissible Explosives, Mining Equipnent and Apparatus approved prior to January 1, 1923, by S. P. HOWELL, L. C. LSLEY, D. J. PARKER and A. C. FIELDNER. ·p. 22.

Sodium Sulphate: Its Sources and Uses, ·y ROGER C. WELLS. Pp. IV. + 43.

Geology and Ore Deposits of the Creede District, Colorado, by WM. H. EMMONS ·nd ESPER S. LARSEN. Pp. IX. + 198.

The Commercial Granites of New England, by T. NELSON DALE. Pp. XV. + 488.

The Kotsina-Kuskulana District, Alaska, ·y FRED H. MOFFIT and J. B. MERTIE, JR. ·p. VII. + 149.

Ilsemannite at Ouray, Utah, by FRANK

Mineral Resources of the United States, 1920—Part 1.

Mineral Resources of the United States in 1920—Introduction, by G. F. LOUGHLIN. Pp. 155a.

Coke and By-Products in 1921, by R. S. MCBRIDE. Pp. 444.

Peat in 1922, by K. W. COTTRELL. Pp. 6.

Surface Waters of Wyoming and Their Utilisation, by ROBERT FOLLANSBEE. Pp. X. + 331.

Geology and Ground-water Resources of Sacramento Valley, California, by KIRK BRYAN. Pp. XI. + 285.

The Industrial Utility of Public Water Supplied in the United States, by W. D. COLLINS. Pp. 59.

Comparative Tests of By-Product Coke and Other Fuels for House-Heating Boilers, by HENRY KREISINGER, JOHN BLIZARD, H. W. JARRETT and J. J. MCKITTERICK. Pp. 21.

Tests of Low-Grade and Complex Ores in Colorado, by WILL H. COGHILL and C. O. ANDERSON. Pp. 67.

New Patents.

THIS list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5. Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

22166—Beckett, E. G.—Production of anthraquinone derivatives. Sept. 3.

22625—Helbronner, A.—Manufacture of chromates, etc. Sept. 8.

22429—Keller, A.—Manufacture of sulphuric acid. Sept. 6.

22447—Tokalon, Ltd.—Manufacture of oleo stearate or glyceryl. Sept. 6.

Specifications Published this Week.

175987—Silica Gel Corporation.—Process of recovering liquid solutes from non-aqueous solutions.

202664—Saltrick, W. A.—Manufacture of iron-chromium alloys.

Alkali thiosulphates, carbonates, and sulphocyanides.—Liquors containing alkali thiosulphates and other less soluble alkali salts such as carbonates, which may be products of gas-purifying processes such as those described in Specifications 169,996 and 170,572, are evaporated until the boiling point reaches 120° C. at atmospheric pressure, when the salts such as alkali carbonates separate, and the crystals are removed in a centrifugal apparatus. The solution is then cooled to obtain crystals of thiosulphate. The mother liquor may be further concentrated to obtain a second crop of thiosulphate crystals; the final mother liquor contains sulphocyanides. The thiosulphate crystals are washed and recrystallised, the mother liquor being returned to the evaporator.

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THE CHEMICAL NEWS,

VOL. CXXVII. No. 3312.

[BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE: LIVERPOOL, 1923.]

SECTION B—CHEMISTRY.
SOME ASPECTS OF THE PHYSICAL CHEMISTRY OF INTERFACES.

By PROFESSOR F. G. DONNAN, C.B.E., F.R.S., PRESIDENT OF THE SECTION.

It was at the last meeting at Liverpool, in 1896, that I first had the honour of attending a gathering of the British Association. On that occasion Dr. Ludwig Mond, F.R.S., was President of Section B, and I shall never forget the interest and pleasure I felt in listening to the Address of that great master of science and scientific method. Little did I dream that in 1923 I should have the honour and privilege of occupying the Chair of Section B at Liverpool.

Looking back on the Liverpool Meeting of 1896, one can say now that it came at the dawn of a new era in the development of physico-chemical science. The X-rays had just been discovered by Röntgen. Perrin had proved experimentally (1895) that a negative electric charge was associated with the cathode rays and had surmised that these so-called "rays" were constituted by electricity in motion, thus corroborating Crookes' brilliant views of a decade earlier and demonstrating that Lenard was wrong. Sir J. J. Thomson had just begun that splendid series of researches which resulted not only in the complete elucidation of the nature of the cathode "rays," but also in the discovery of the negative electron as a constant, universal, and fundamental constituent of all matter.

The discovery of the chemically inert elementary gases by Raleigh and Ramsay had begun in 1894, and the series of investigations which finally led to the recognition of the radio-active transformations of atoms and to the discovery of the nature and constitution of the atom itself, were just beginning. During the last twenty-five years the influence of these discoveries on chemical science has been enormous. There has come about a fresh reunion of physics and chemistry, somewhat analogous to that which occurred in the days of Volta and Davy. During the two decades preceding 1896, physical science had been largely concerned with the phenomena of the "ether," with electric and magnetic fields, electromagnetic waves, and the identification of light and other forms of radiant energy as electromagnetic phenomena. Now that the physicists have brought physical science back to the close and intimate study of matter, physics and chemistry have come together again, and the old and homogeneous science of "natural philosophy" has been reconstituted. It is time that the walls which divide our chemical and physical laboratories were broken down, and that the young men and women who come to our Universities to study physics or chemistry, should study the facts and principles of a fundamental science which includes both.

In recent years a great deal of attention has been paid to the phenomena which occur at the surfaces or interfaces which separate different sorts of matter in bulk. During the last quarter of the nineteenth century, both J. Willard Gibbs and J. J. Thomson had shown the peculiar nature of these interfacial or transitional layers. Things could happen in these regions which did not occur in the more homogeneous and uniform regions well inside the volume of matter in bulk. Such happenings might, if they could be investigated, reveal molecular or atomic peculiarities which would be undetectable in the jostling throng of individnals inside. A surface or surface layer represents a sort of thin cross section which can be probed and examined much more readily than any part of the inside bulk. It is indeed only within comparatively recent years that the X-rays have provided a sufficiently fine probe for examining this bulk in the case of crystalline matter.

In the theories of Laplace, Gauss, and Poisson, the field of force surrounding an attracting element or molecule was regarded as essentially uniform in its spatial relations, *i.e.*, the equipotential surfaces were regarded as concentric spheres with the molecule as a small element at the centre. The molecules were thought of as possessing what one might call a very rounded and somewhat monotonous "physical" character as regards their fields of force. In recent years our views have undergone a radical transformation. The field force surrounding a molecule may be very "irregular," and specially localised

round certain active or "polar" groups. ts region of sensible magnitude may be ery variable and relatively small compared ith molecular dimensions. The chemical mstitution of the molecule is now regarded ; determining the varying nature of the eld of force surrounding it, so that parts of ie molecule possessing high "residual iemical affinity" give rise to specially owerful regions of force. In this way the der "physical" theories of cohesion cording to central forces with uniform ientation have been to some extent re-aced, or at all events supplemented, by chemical" theories according to which the tractive force-fields are highly localised und active chemical groups and atoms, e relatively minute in range, and can be turated or "neutralised" by the atoms or oups of neighbouring or juxtaposed mole-ules.

Dr. W. B. Hardy has been the chief ioneer in the development of these newer eories, having been led thereto by his re-earches on surface tension, surface films, omposite liquid surfaces and static friction ind lubrication.

His ideas are clearly expressed in the fol-owing: "If the field force about a mole-ule be not symmetrical, that is to say, if he equipotential surfaces do not form pheres about the centre of mass, the ar-angement of the molecules of a pure fluid nust be different at the surface from the urely random distribution which obtains n the average in the interior. The in-vardly directed attractive force along the normal to the surface will orientate the nolecules there. The surface film must herefore have a characteristic molecular rchitecture, and the condition of minimal otential involves two terms—one relating o the variation in density, the other to the rientation of the fields of force." (1913.)

These conclusions have been confirmed by W. D. Harkins, who has found that in the case of very many organic liquids the 'adhesional work" towards water is greatly increased by the presence of oxygen atoms (as in alcohols, acids, and aldehydes). The very symmetrical halogen derivatives, CCl_4 and $C_2H_4Br_2$, give markedly low values for their adhesional work towards water, and that in the case of unsymmetrical mole-cules, the adhesional work towards water is determined by the presence of certain active atoms or atomic groups.

The question of the orientation of mole-cules at the surfaces of liquids has been-ly thin and invisible films formed by the primary spreading of oily substances on the surface of water. In a continuation and development of the work of Miss Pockels, the late Lord Rayleigh showed many years ago that when olive oil forms one of these invisible films on water, there is no fall in surface tension until the surface concentra-tion reaches a certain very small value. He made the highly interesting and important suggestion that this concentration marks the point where there is formed a con-tinuous layer just one molecule thick. This work was repeated and extended by H. De-vaux and A. Marcelin, who showed the correctness of his suggestion that the pri-mary film consists of a *unimolecular* layer. It appears, however, that the fall in surface tension which he ascribed to the building up of a bimolecular layer, is due to the closer packing of the molecules of the uni-molecular layer.

Let us now consider another type of for-mation of surface layers at the surfaces of liquids—namely, the case where a sub-stance dissolved in a liquid concentrates preferentially at the liquid-air or liquid-vapour interface. Gibbs, and later J. J. Thomson, have shown that if a dissolved substance (in relatively dilute solution) lowers the surface tension, it will concen-trate at the surface. That such a phenome-non actually occurs has been qualitatively demonstrated in the experiments of D. H. Hall, J. von Zawidski, and F. B. Kenrick and C. Benson, by the analysis of foams and froths. In 1908 S. R. Milner used the same method in the case of aqueous solu-tions of sodium oleate, and arrived at a mean value of 1.2×10^{-10} gram mols. ex-cess concentration per sq. cm. of surface. Now, in the case of dilute solution, we can calculate q, the amount concentrated or "adsorbed" in the surface per sq. cm. (ex-cess surface concentration) by making use of the equation of Gibbs,

$$q = -\frac{d\gamma}{d\mu}$$

where γ = surface tension and μ = chemi-cal potential of the adsorbed substance in the bulk of the solution. Writing $\mu = RT \log a + k$, where a = "activity" of the so-lute, and k is a quantity dependent only on the temperature and nature of the solute and solvent, $d\mu = RT\,d \log a$, and so Gibbs' equation can be written in the form

$$q = -\frac{1}{RT}\frac{d\gamma}{d \log a}.$$

If for very dilute solutions (or "ideal" solutions) we can write

$$q = -\frac{1}{RT}\frac{d\gamma}{d\log c} = -\frac{c}{RT}\frac{d\gamma}{dc}.$$

In this way Milner has calculated from Whatmough's data for aqueous solutions of acetic acid that the "saturation" value of q is 3.3×10^{-10} mols. per sq. cm., from which it follows that the area per molecule in the surface is 50×10^{-16} sq. cm. In a similar manner, Langmuir has calculated from B. de Szyszkowski's data for aqueous solutions of propionic, butyric, valeric, and caproic acids that the surface area per molecule adsorbed in the saturated layer is equal to 31×10^{-16} sq. cm., whilst Harkins has arrived from his own measurements for butyric acid at the value 36×10^{-16} sq. cm.

In 1911 Dr. J. T. Barker and myself made a direct determination of q for a solution of nonylic acid in water. For a practically saturated surface layer it was found that q was about 1.0×10^{-7} grm. per sq. cm., or 3.1×10^{14} molecules per sq. cm. From this result it follows that the surface area per molecule is 26×10^{-16} sq. cm.

If we consider these various values, it will be at once evident that they are not very different from the values found by Langmuir and by Adam for the oriented unimolecular layers of practically insoluble fatty acids resting on the surface of water. That in the present case some of the values are larger might easily be explained on the ground that these adsorption layers are partially, or completely, in the state of "surface vapours." For Adam and Marcelin have recently made the important discovery that the unimolecular surface films investigated by them may pass rapidly on increase of temperature from the state of "solid" or "liquid" surface films to the state of "vaporised" surface films, in which the juxtaposed molecules become detached from each other and move about with a Brownian or quasi-molecular motion, probably communicated to them by the thermal agitation of the water molecules to which they are attached.

It is, indeed, highly probable that the molecules which are concentrated in the surface from the state of solution in the liquid phase are not in quite the same situation as the molecules of practically insoluble substances which are placed on the surface. In the former case the molecules are still "dissolved," so that they will be more subject to thermal agitation and less able to form a juxtaposed unimolecular layer. They may also be "hydrated." The difference between the two cases is rendered very evident from the fact that in the production of surface layers from dissolved molecules of the fatty acids (and other "surface active" substances) there is a very marked fall of surface tension, whilst the uncompressed unimolecular surface films placed on the surface from outside do not affect the surface tension of the water. Thus the moleculas of the surface-active substance in the former case are in much closer relation to the solvent molecules, and are in kinetic equilibrium with the molecules of both solvent and solute in the bulk of the liquid. Nevertheless, the agreement as regards order of magnitude in the values of the surface area per molecule in the two types of case is certainly very suggestive and significant. Moreover, the experiments of Mr. Iredale show that molecules which are adsorbed on the surface from the vapour phase lower the surface tension, and are therefore from this point of view comparable with molecules concentrated in the surface from the bulk of the liquid phase.

The question as to whether the simplified form of Gibbs' equation yields a sufficiently accurate value for the excess surface concentration can scarcely be decided without more experimental data. In the experiments made by Dr. Barker and myself, the values calculated from the surface tension-concentration curve were 1.3×10^{-7} and 0.6×10^{-7} grm. per sq. cm., according as the value of the van't Hoff factor i for the very dilute solutions of nonylic acid was taken as 1 or 2 respectively; whilst the corresponding directly determined value was about 1.0×10^{-7} grm. per sq. cm. This discrepancy was probably well within the experimental error of our measurements.

Within the last few years H. A. McTaggart has made a number of experiments on the electric cataphoresis of gas bubbles in aqueous solutions and other liquids. He finds that aliphatic acids and alcohols in aqueous solution reduce the surface P.D., and that this effect runs parallel with their influence on the surface tension of water. He also finds that acids reduce the P.D. These results may be regarded as a corroboration of those obtained by Kenrick. McTaggart has found that the nitrates of tri- and tetravalent cations have a powerful effect in not only reducing but reversing the P.D. (*i.e.*, the bubble becomes positively

charged). His experiments also show that polyvalent negative ions, such as the ferrocyanide ion, *act in the opposite direction to* the polyvalent cations—*i.e.*, they increase the negative charge on the bubble or diminish a previously existing positive one. These results are of great interest, inasmuch as *they show the powerful effects produced by* polyvalent ions on the P.D. existing in the surface layer of an aqueous solution. As we shall see presently, very similar results have been obtained at liquid-liquid and solid-liquid interfaces. But it is of great importance to know what happens at the air-liquid interface, since we can largely discount the chemical and physical influence of the gas phase.

Although the electrometric method employed by Kenrick and Thorwaldson only *gives comparative results* (since two interfaces must always be simultaneously used), whilst the cataphoresis method gives results for a single interface, it is necessary to observe that the electrometric method measures the *total* fall of potential from the bulk of one phase to the bulk of another. *The cataphoresis method measures what* Freundlich has called the "electrokinetic" P.D.—that is to say, the potential drop between the limiting surface of the "fixed" part of the double layer and the rest of the liquid. The two values need not necessarily coincide.

Let us now inquire how far the phenomena which we have seen to be characteristic of a gas-liquid interface occur also at the interface between two immiscible or partially miscible liquids. Many years ago it was shown by Gad and by Quincke that a fatty oil is very readily dispersed in the form of an *emulsion by a dilute solution of* caustic soda. A neutral hydrocarbon oil can be similarly emulsified in a dilute aqueous solution of alkali if one of the higher fatty acids was dissolved in it, whilst the lower fatty acids do not produce a similar action. It was shown that the action runs parallel to the lowering of interfacial tension and must be ascribed to the formation of a soap, which lowers the interfacial tension and concentrates at the interface.

I cannot conclude this account of certain aspects of surface actions and properties without making a passing, though all too brief, reference to the beautiful investigations of Sir George Beilby on the amorphous layer. He has shown that when the surface of crystalline matter is subjected to layer of a vitreous or amorphous character —a "flowed" surface—in which the particular ordered arrangement of the molecules or atoms which is characteristic of the crystalline matter largely disappears. Dr. Travers and Mr. R. C. Ray have recently obtained a very interesting confirmation of the Beilby Effect. The heats of solution (in kilogram calories per gram mol) of vitreous silica and *silver sand* (*silica as crystalline quartz*) in aqueous hydrofluoric acid were found to be 37.24 and 30.29 respectibely. After grinding for fifteen hours the corresponding values were 36.95 and 32.46 *respectively*. If we assume that the internal energy of the amorphous phase produced by grinding is the same as that of the vitreous silica (silica glass), we can calculate from these results that about 31 per cent. of the crystalline silica has been converted by grinding into "amorphous" silica. The densities of silica glass and silver sand were found to be 2.208 and 2.638 respectively. After fifteen hours' grinding the density of the latter was lowered to 2.528. On the same assumption as before, it follows that about 26 per cent. of the quartz has been converted into the vitreous condition. The *difference between the* figures 31 and 26 is doubtless due to the approximate character of the assumption underlying the calculations and to experimental errors. There seems little doubt, however, about the soundness of the main conclusion—namely, that the mechanical action of shearing stress on crystalline matter is to produce a random molecular or atomic distribution in the surface layers.

This discussion, necessarily brief and limited, of certain aspects of the properties of surfaces—molecular orientation, surface concentration or adsorption, electrical or ionic polarisation—has dealt very largely with states of thermodynamic equilibrium.

[British Association for the Advancement of Science. Liverpool, 1923.]

SECTION A.—MATHEMATICS AND PHYSICS.

ON THE ORIGIN OF SPECTRA (RECENT PROGRESS).

Address by Professor J. C. McLennan, F.R.S., President of the Section.

(*Continued from Page* 202.)

If this view be accepted, it follows that if

an element its most loosely bound electron, we should expect to find that the orbits which remained were characterised by the same quantum numbers as defined them in the neutral atom. Moreover, except in certain special cases, these orbits would be identical in type with those of the neutral atoms of the next lighter element. The exceptional cases would include those elements whose atomic structure involved the commencement of the development of an inner system of orbits, such as those of the 3_3, 4_3, 4_4, &c., groups. Subject to these limitations, we should expect to find that if the *n* last-bound electrons were removed from a neutral atom of an element the orbits that remained in this atom would be identical in type with those of the neutral *atoms of the nth lighter element.* This would mean that the arc spectrum of the monovalent positive ion of arc element would be identical as to types of series involved with the arc spectrum of the neutral atoms of the next lighter element. There would be this difference, however, that in the series formulæ of the spectrum of the ion the Rydberg constant would be 4K, whereas in the series of the spectrum of the neutral atoms of the lighter element it would be K. Putting the matter as it is ordinarily stated, the spark spectrum of an element should be made up of series of the same type as those of the arc spectrum of the next lighter element. This is known as the Kossel-Sommerfeld Displacement Law.

In terms of Bohr's theory the 9-fold value of the Rydberg constant would be interpreted as meaning that aluminium atoms which emitted this spectrum had lost two electrons, and were represented by Al+++, or, as it is now written, Al(III). The 16-fold Rydberg constant would, on the same theory, also be interpreted as meaning that the atoms of silicon which emitted this spectrum were those that had lost three electrons, i.e., Si(IV). These results, it will be seen, amply confirm the view that the bound electrons in the neutral atoms of sodium Na(I), are of the same type and are characterised by the same quantum numbers as those of the singly ionised atom of magnesium, Mg(II), of the doubly-ionised atom of aluminium, Al(III), and of the trebly-ionised atom of silicon, Si(IV).

What has been found to be true of the spectra of sodium, magnesium, aluminium, and silicon, will no doubt be found to be true of the spectra elements lithium, beryllium, boron, and carbon. The spectra of beryllium and boron are extremely meagre in wave-lengths, and but little is known of their spectral series. The spectrum of carbon, however, especially in the extreme ultra-violet, has been well worked out by a number of observers, and particularly so by Simeon.

In the spectrum of beryllium the doublet $\lambda = 3131.194$ A, $\lambda = 3130.546$ A, has been shown to be the first member of a principal and a second subordinate series of doublets. Moreover, Back, who recently investigated its magnetic resolution, has found that the magnetic components are of the D_1 and D_2 type, just as Kent has shown the magnetic components of the close lithium doublet $\lambda = 6708$ A to be. It will, therefore, probably be found when the spectrum of beryllium has been extended that the doublet $\lambda = 3131.194$ A, $\lambda = 3130.546$ A, will prove to be the first member of the doublet series of the positive singly-charged atom of beryllium, with a Rydberg constant for the series of 4K. In the spectrum of boron the doublets $\lambda = 2497.73$ A, $\lambda = 2496.78$ A, and $\lambda = 2089.49$ A, $\lambda = 2088.84$ A, particularly the latter, merit attention in looking for a 9K series. In the ultra-violet spectrum of carbon there is a strong doublet at $\lambda = 1335.66$ A, $\lambda = 1334.44$ A, and another nearly as strong at $\lambda = 1329.60$ A, $\lambda = 1329.07$ A. These two also merit attention in any attempt to identify 16K series for this element.

In considering the general validity of the Kossel-Sommerfeld Displacement Law the recent work of Catalan on the series spectra of manganese, chromium and molybdenum is of interest.

In this paper an attempt has been made to outline some of the leading features of the quantum theory as it is being used to solve the problems of atomic structure as well as of those connected with the origin of *radiations emitted* by atoms. Other illustrations of special interest might have been drawn from the treatment of problems that have arisen in a study of band spectra and of fluorescence phenomena. The recent work of Cabrera, Epstein, and Dauvillier, on paramagnetism, too, has a most interesting connection with the development of inner systems of electronic orbits in atoms in Bohr's scheme of the genesis of atoms.

I venture to think, however, that the few illustrations presented may serve, in a measure, to indicate the power and also the beauty of the methods being put forward to elucidate the problem of the origin of radiation.

ORGANIC MERCURY COMPOUNDS.

PART II.

By R. F. HUNTER, F.C.S.

(Continued from Page 205.)

Mercury dimethyl is the first alkyl mercury compound we shall consider.

It can be prepared in several ways, for instance, by the action of sodium amalgam on methyl iodide, from zinc dimethyl and methyl mercuric iodide, from methyl mercuric iodide and potassium cyanide, from mercuric chloride and ether methyl magnesium iodide or aluminium carbide. It is a colourless, highly refractive and excessively poisonous liquid, and reacts with halogens, acids, metals, iodocyanogen, stannous chloride, phosphorus and antimony trichloride, with potassium permanganate and with mercuric salts.

The important synthetical compound methyl mercuric acetate is prepared from it by heating it with glacial acetic acid in a sealed tube for some time at 130°; methane is produced in this reaction.

The homologue, mercury diethyl, is prepared by similar methods, *e.g.*, from zinc diethyl and mercuric chloride, from ethyl bromide and sodium amalgam, from ethyl mercuric iodide and potassium cyanide, etc. It reacts in a similar manner with halogens, metals, acids, potassium permanganate, mercuric salts, etc., with arsenobenzene, on heating at 150°, a reaction takes place in which phenyl diethyl arsine is formed and metallic mercury produced.

Among the other alkyl mercury compounds which have been prepared, we might mention: mercury dipropyl, di isobutyl, di sec. butyl, di isoamyl, di octyl, the preparations of which can be found in Whitmore's excellent book on the subject.

A number of mercury compounds have been prepared from the olefines. For instance, ethylene reacts with aqueous solutions of mercuric salts, giving a variety of complex mercury compounds. These have been classified as:

Ethanol mercuric salts;
Ethyl ether mercuric salts;
and products of the form C_2H_3Hg (OR)X.

As derivatives of ethylene we might mention Ethenol mercuric chloride, bromide and iodide; Ethanol mercuric nitrate and sulphide; $\beta\beta'$ di chloro mercuric diethyl ether; Mercurous and mercuric di ethylene oxides.

Certain products obtained from ethylene and alcoholic solutions of mercuric salts, such as α Acetoxymercuri, β methoxy ethane, and α *Acetoxy mercuri* β *ethoxy ethane*. Mercury compounds have also been prepared from propylene, for instance, α Acetoxymercuri β hydroxypropane, and from isobutylene: chloromercuri hydroxy isobutane.

The mercury compounds of acetylene are of interest from the synthetical production of acetaldehyde from acetylene in the presence of salts of mercury. We might mention mercury bis mono chloro acetylene as an acetylene derivative of particular interest.

Ethyl alcohol in the presence of alkali reacts with mercuric salts producing a variety of compounds, of which the most important are the mercarbides, which are compounds in which the hydrogen of a CH_3 group is completely replaced by mercury. Ethane hexamercarbide, $C_2Hg_6O_2(OH)_2$, is typical, and is produced by the refluxing of yellow HgO, K O H, and alcohol for several hours.

The dichloride and corresponding nitrate and sulphate of ethane hexamercarbide have been prepared.

Mercury compounds of unsaturated alcohol, such as vinyl, allyl alcohols, have been prepared, and quite a large amount of research has been carried out on the action of mercuric salts on allyl alcohol.

The mercury derivatives of the fatty acids, aldehydes, ketones, and acid amides have been subject to much investigation. A variety of compounds are prepared from carbon monoxide and alcoholic solutions of mercuric salts. We might mention acetoxy mercuri formic methyl ester and the corresponding ethyl compounds as examples. Among the mercurated acetic acids we have

Bromo mercuri acetic acid;
Anhydro hydroxy mercuri acetic acid;
Nitrate mercuri acetic acid;
Mercuri nitrate mercuri acetic acid;
Dichloromercuri acetic acid;
Trichloromercuri acetic acid; and
Tri hydroxy mercuri acetic acid.

Among the mercurated propionic acids, we have β mercury bis propionic acid and its corresponding anhydride, and the anhydride of α hydroxy mercuri propionic acid.

Compounds from unsaturated acids have also been prepared such as the anhydride of α hydroxy mercuri, β hydroxy propionic acid, and the anhydride of hydroxy mercuri α hydroxy β butyric acid.

The mercury salts of α acetoxy mercuri β hydroxy mercuri and β hydroxy methyl succinic acid have been prepared.

As examples of mercury aldehyde compounds we have

Mercuri chlorate, mercuri aldehyde, mercuri nitric, mercuri acetaldehyde.

A variety of compounds are obtained when acetone reacts with mercury compounds. We might state

Tetra acetoxy mercuri diacetone hydrate; and

Tri mercuri diacetone hydrate as examples.

Mercury acetamide, $(CH_3\ C\ O\ N\ H)_2$ Hg, is typical of the mercury derivatives of acid amides, and is prepared by adding yellow HgO to melted acetamide and allowing the temperature to rise slowly to 180°. Among the other amide derivatives which have been prepared by various workers at different times, we might mention

Mercury monochloro acetamide;
,, nitro acetamide;
,, propionamide;
,, oxamide;
,, succinamide;
,, tartamide and fumaramide.

The mercury derivatives of aromatic hydrocarbons and nitro compounds have been dealt with fully by Whitmore, and hence nothing more than the briefest of reviews will be given.

A typical example is mercury diphenyl, which can be prepared by several methods:

1.—By action of sodium amalgam on C_6H_5Br.

2.—From C_6H_5Br, Hg Cl_2, and sodium.

3.—From Phenyl arsenious oxide and Hg Cl_2.

4.—From phenyl magnesium bromide and Hg Cl_2.

5.—From phenyl hydrazine and mercuric oxide.

6.—From phenyl mercuric iodide and sodium amalgam.

Also from phenyl mercuric bromide and K_2S, and from phenyl mercuric acetate and sodium stannite.

The compounds react in much the same way as the alkyl compounds do; thus it reacts with halogens, metals, and chlorides, non-metallic halides, acids, mercuric salts, organic halides, acid anhydrides, with sulphur and with oxidising agents.

Other phenyl mercuric compounds deserving mention are phenyl mercuric hydroxide, chloride, bromide, iodide formate, propionate, acetate, cyanide, nitrate, sulphate, carbonate and sulphocyanide.

Among the tolylmercuric compounds we have o mercury di tolyl, o tolyl mercuric chloride and nitrate, m mercury di tolyl, m tolyl mercuric nitrate, m mercury di tolyl, m tolyl mercuric chloride and bromide, p mercury di tolyl, p tolylmercuric chloride, bromide and iodide, and p tolylmercuric acetate and corresponding nitrate.

The benzyl mercury compounds worthy of note are: mercury di benzyl prepared from benzyl magnesium, chloride and mercuric chloride, and benzylmercuric chloride prepared from mercury di benzyl and alcoholic Hg Cl_2. The corresponding bromide, iodide, and acetate have been described.

Mercury derivatives of higher benzene homologues are known, for instance:

Mercuri bis 3, 4 dimethyl benzene,
,, 2, 4 ,, ,,
,, 2, 5 ,, ,,
,, 2, 4, 6 tri methyl benzene.

Mercuri bis penta methyl benzene, and mercuri bis 2 methyl 5 isopropylbenzene have been described.

Mercury derivatives of cyclo hexane are known; for instance, we are acquainted with cyclo hexylmercuri chloride, the corresponding bromide, cyanide, and sulphide. Among the mercury derivatives of aromatic nitro compounds, we have o nitro phenyl mercuric chloride prepared from nitro benzene and mercuric acetate; m and p nitro phenyl mercuric chloride. A compound of this class worthy of note is anhydride of o nitro benzal-dimercuric hydroxide.

Mercury derivatives of sulphonic acids have been prepared, and mercury derivatives of phenylacetylene are described by various workers, but compounds which do deserve mention are the derivatives of naphthalene. A typical example of these is α mercury di naphthyl, which is obtained when α bromonaphthalene is heated with xylene and sodium amalgam in a pasty condition on an oil bath for some 20 hours. It reacts with acids, metals, halogens, mercuric salts, oxides of nitrogen, with arsenious chloride and thionyl chloride.

Other compounds of this class worthy of mention are: α Naphthyl mercuric chloride bromide, iodide, formate, acetate, butyrate, nitrate and sulphide, β naphthylmercuric halides and sulphide.

We have now to consider one of the most interesting groups of organic mercury com-

pounds, namely, the mercury compounds of aromatic amines, which constitute one of the largest families of the mercury compounds.

The first compounds to be considered are the double compounds of aniline and mercury salts. Typical of this class are what are known as "*mercuric chloride compounds*." When aniline and $HgCl_2$ in alcohol are mixed, we obtain a white crystalline compound, $(C_6H_5N\ H_2)_2\ (Hg\ Cl_2)_3$; other compounds of this kind are: $(C_6H_5NH_2)_2\ Hg\ Cl_2$, $C_6H_5N\ H_2\ Hg\ Cl_2$, and $C_6H_5N\ H_2\ H\ Cl\ Hg\ Cl_2$. Corresponding mercuric bromide, iodide, nitrate, cyanide and chlorate compounds are mentioned in the literature of the subject. In 1875, while studying the action of aniline on alcoholic solutions of mercuric chloride, Wislicenus prepared a yellow white, very insoluble compound, $C_6H_5N\ Cl\ Hg$. The compound was named "phenylated white precipitate," and was studied very thoroughly by Forster.

This brings us to the study of the true compounds of aromatic amines, p amino phenylmercuric acetate is a typical compound and can be prepared from N. mercuri aniline and acetic acid, aniline acetate, mercuric acetate, or from aniline acetate and mercuric oxide, or from aniline and mercuric acetate, the last being the usual method of preparation; it is essential to use freshly distilled aniline. The compound reacts with halides, can be acetylated, further, it can be diazotized and coupled, also it reacts with dinitro phenylyddine and with propargylacetal.

p Mercuri bis aniline is another aniline derivative of note, and can be prepared from p amino phenyl mercuric acetate and sodium thiosulphate, from p aminophenylarsenious oxide and sodium hydrate and mercuric chloride, also from p mercuric bis acetanilide, by heating with alcoholic potassium hydroxide.

p Amino phenyl mercuric hydroxide and its anhydride are obtained by dissolving p amino phenyl mercuric acetate in dilute K O H and treating with concentrated (30 per cent.) caustic potash.

p Amino phenyl mercuric chloride exists in both crystalline and amorphous forms, and reacts with sodium thiosulphate, dinitro diphenyl pyridine chloride, propargylacetate, and also with ethoxy acrolein aceal.

Other aniline derivatives are p amino, phenylmercuric bromide, iodide, nitrate, acid sulphate, sodium p aminophenyl mercuric thiosulphate, o aminophenyl mercuric acetate and chloride, 2 amino 5 nitrosophenyl mercuric chloride, 2, 4 diacetoxymercuri aniline.

Mercury compounds of nitroanilines are known; for instance, nitro aniline reacts to yield 4 acetoxy mercuri 2 nitro aniline, and 4, 6 diacetoxy mercuri 2 nitroaniline. Mercury derivatives of monomethylaniline and dimethylaniline are known. Examples are, p methyl aminophenylmercuric acetate, p mercuri bis monomethylaniline, p nitro o acetoxymercuri monomethylaniline of the first, and p mercuri bis dimethylaniline p dimethyl amino phenylmercuri acetate, hydroxide chloride, and of the second, p bromo dimethylaniline reacts to yield o acetoxy mercuri p bromo dimethylaniline is prepared from o nitro dimethylaniline.

In a similar manner, as examples of derivatives of ethylaniline, we have:

p Mercuri bis monoethylaniline, p ethylaminophenyl mercuric acetate, hydroxide and chloride.

For derivatives of diethylaniline we have p mercuri bis diethylaniline, p diethylaminophenyl mercuric acetate, hydroxide and chloride.

As examples of mercury derivatives of acid anilides we have:

N mercuri bis formanilide;

N mercuri bis acetanilide; and

p Acetaminophenyl mercuric acetate, p mercuri bis diphenylamine, p hydroxy mercuri diphenylamine, p mercuri bis methyl diphenylamine are derivatives of diphenylamine, 2 acetoxy mercuri phenylglycine ethyl ester.

$Ac\ O\ Hg\ C_6H_4\ N\ H\ CH_2\ CO_2\ C_2H_5$ is an example of an anilide fatty acid derivative.

2 Chloromercuri phenyl α aminopropionic ethyl ester $Cl\ Hg\ C_6H_4\ N\ H\ CH\ (CH_3)\ CO_2\ C_2H_5$ is another example.

Mercury derivatives of the three toluidines have been described; as examples of such we have:

3 Methyl 4 aminophenyl mercuric acetate;

Dihydroxy mercuri o toluidine;

Diacetoxy mercuri m toluidine;

Tri acetoxy mercuri m toluidine.

Acetoxy mercuri p toluidine;

Hydroxy mercuri p toluidine;

Chloro mercuri p toluidine.

Other amino aromatic derivatives of mercury are:

Acetoxy mercuri dimethyl p toluidine;

p Acetoxy mercuri o aceto toluidide,

Dichloro mercuri o aceto toluidide;
p Acetoxy mercuri m acetotoluidide.
The anhydride of o hydroxy mercuri p acetotoluidide.
Di acetoxy mercuri o tolyglycine ethyl ester;
o Acetoxy mercuri p tolylglycine ethyl ester;
p Benzylamino phenyl mercuric acetate;
2, 4 Diacetoxy mercuri and naphthylamine; and
2 Acetoxy mercuri naphthionic acid.

ODOUR CONDITIONS.

By John Missenden.

To place into categories the various substances which produce odour, to enumerate definite values for these substances, and to define some tangible link between odiferous bodies and their chemical properties, a certain amount of postulation is essential. Referring to the works of Bertbelot, Kremer, Durrans, Tyndall, Linné, and others, one finds such a wide divergence of views as to render these problems seemingly incapable of solution. Indeed, the assertions of some that no measureable linkages exist are almost justifiable. If, however, all these investigations and opinions are collated, and their substance combined with the results of later research, a working hypothesis and tabulation becomes practicable, and might form the base of more intensive and expert examinations within the next few years.

The first consideration is that of the physiological conditions governing the organs of smell, with the chemical conditions being interdependent. In the first place, all substances that can be detected by the olfactory senses must be volatile;[1] consequently, the *intensity* of odour may be practically determined by *degrees of volatility*. In the second place, the substances in their volatile state must be capable of solution in the lipinous fluid of the olfactory organs, and their *degree of solubility* therein determines the remaining component of intensity. And, in the third place, there must be some *chemical reaction* with the lipinous fluid; this would determine the *quality* of the odour.

Three conditions, then, based upon the most fundamental facts which are already common knowledge, provide working data. Their tabulation is as follows:—

(*a*) degree of volatility:)
(*b*) degree of solubility in lipins:) intensity;
(*c*) chemical reaction with lipins: quality.

(*a*)—Degree of Volatility.

While a substance, to be odiferous, must be volatile, it does not follow that all volatile substances are odiferous. Water, for instance, is volatile; yet it is said to be odourless. If this datum is regarded from a relative standpoint, water becomes odiferous, inasmuch that it dilutes the lipinous fluid, thereby causing quite a perceptible olfactory state when present in sufficient quantities.

Volatility may be measured by loss of weight over a standard period of time. If this period be taken as 1×10^{10} hours, and the amount of the substance be standardised as 1,000 grams, a range of numerical values would result under uniform conditions of temperature and pressure. Suppose trinitrobutyltoluene be selected as an example. According to Berthelot's calculations, 1 gram of this body will lose about $\frac{1}{10^{15}}$ grams of its weight in one hour in order to be detected by the olfactory senses. That is to say, if the suggested standard be adopted, the degree of solubility would be 0.01. Iodoform, losing about $\frac{1}{10^{12}}$ grams per hour, would lose about 10 grams of its weight (1,000 grams) in 1×10^{10} hours in simple rate, or $10e$ grams at compound rate, where e is the exponential. This is the value when iodoform is just discernible, and would obviously vary according to the sensitiveness of the olfactory organs. The difficulty may be overcome by calculating the value at *maximum* volatility at N.T.P.

Peisse[2] has arranged all known perfumes in graded degrees of volatility, and a useful indication of relative losses of weight may be derived therefrom. Woker[3] made some observations upon the dependence of volatility upon intramolecular tension, and suggested that the intensity of odour was increased in direct ratio. This is so to a certain extent, but due allowance must be made for the solubility of a substance in the lipinous fluid, as it has been found that some highly volatile bodies are almost insoluble in lipin—hence practically odourless. Pyrocatechin, $C_6H_4(OH_2)_2(1:2)$, is a case in point.

(b)—Degree of Solubility in Lipins.

The theory, part of which has since become an incontrovertible fact, that an odiferous substance must be soluble in water *and* lipins, emanated from Backman.[4] His theory is correct in the case of water, otherwise how can he account for the odour of volatile oils? Whereas these oils are known to be soluble in lipins, they are totally insoluble in water. Both water and the lipinous fluid undoubtedly assist each other, but they are by no means indispensable to each other for all substances, if for some.

Investigation has not provided one instance of where a substance, either concentrated or dilute, which is insoluble in lipinous fluid, posses odour; while there is much evidence to show that lipin-soluble substances always affect the olfactory nerves in a perceptible degree, providing a sufficient quantity be present. Such substances as bornyl acetate, phenol, and thiocyanide compounds stand in good contrast to mercury (odourless) and pyrocatechin (scarcely perceptible).

There are a number of properties, too numerous to discuss in detail within such a paper as this, which govern the activities of lipin. One finds, for instance, that chlorine, on conversion into a chloride, loses the greater part (if not all) of its odour; and solubility, combined with volatility, accounts for the decrease. The reasons for the change have been discussed by Teudt,[5] and by Ungerer and Stoddard,[6] who more or less claim that odour is dependent upon the rate of molecular vibration. Heller[7] energetically condemns the hypothesis; nevertheless, it is a sound one—but only as one of the conditions producing odour, and governing intensity.

(c)—Chemical Reaction with Lipins.

Some very interesting postulatory work has been executed by Linné, and Zwaardemaker, who endeavoured to classify the qualities of odours. The term "odoriphor"[8] was introduced, which corresponded with the "osmophoric group" of Rupe and Majewski,[9] and the aromatophors" of Klimont.[10] Many other terms have been introduced.

The quality of an odour (*i.e.*, whether it is aromatic, repulsive, and so forth) may be determined by the results of interaction with lipinous fluid, and not by the rate of interaction. At the same time, some overlap in these definitions is unavoidable: as in the instance of ammonia. Ammonia produces a pungent odour which is objectionable; firstly because of the vibratory speed of interaction, and secondly because the residual products of interaction violently attack the subcutaneous tissue through the pores. The first, which imparts a sensation of burning, denotes intensity; the second is quality.

The determination of residual products after interaction with the lipinous fluid is of great importance, therefore, and all too little work has been carried out in this direction. Some observations have been made very much along the lines of Zwaardemaker's postulations, except that the nomenclature has been adjusted to correspond with that of Rupe, Majewski, Klimont, and others. The names have been placed in columns, as under, the first of which represents the new nomenclature, the second is that of Zwaardemaker, the third contains exemplary compounds, and the fourth the obsolete name.

I.	II.
Etherophors.	Ethereal odours.
Aromatophors.	Aromatic odours.
(a) Camphoraceous	
(b) Almond.	
(c) Citral.	
Enosmophors.	Fragrant odours.
Ambrosophors.	Ambrosaics.
Aldylophors.	Allyl odours.
Empyreumatophors.	Empyreumatics.
Hircinophors.	Hircon odours.
Kakosmophors.	Repulsive odours.
Fœtidophors.	Fœtid odours.

III.	IV.
Ether, etc.	
Eucalyptol.	Aromatophors.
Acetophenol.	
Cyclic limonene.	
Floral extracts.	Enosmophors.
Trinitrobutyltoluene.	,,
Allyls and cacodyls.	
Durene, etc.	Kakosmophors.
Fatty acids.	Odoriphors.
Quinoline, etc.	Kakosmophors.
Skatol, etc.	,,

It will be appreciated that any attempt at sharp classification has not been attempted, although the various qualities are clearly separated on the whole. M. Appui, of St. Etienne (to whom I am much indebted for very valuable assistance, and who is now engaged upon the lipin reactions) has suggested that the fœtidophors be sub-divided into "pungent" and "irri-

tant," but I do not think that the two classes would be sufficiently defined, as the majority of pungent odours are also irritant.

(*d*)—General Observations.

Although it is impossible to trace any connection between odour and one chemical condition, the correlation of several conditions renders classification more practicable. The intensity of an odour can be measured, once standards are adopted, as the product of the values of volatility and solubility; while the classes under which the residual products fall after interaction with the lipinous fluid determines quality. In the evolution of some standard hypothesis, full credulence can be given to Teudt's theory, although this is but a subsidiary factor. The known laws governing volatility, solubility, and chemical change will, regarded *en masse*, be the laws which govern odour, and it is hoped that this may prove to be the correct fonndation for a more complete survey of the subject; in addition to which some satisfactory conclusions on the question of taste may be formed.

References:

[1] *A gas is classed as a volatile substance.*
[2] *Des Odeurs des Parfums et des Cosmetiques*, 1865; *Perfumery Record*, 1919, p. 268.
[3] *J. Physik. Chem.*, 1906, p. 456.
[4] *J. Phys. Path. gen.*, 1917, p. 1.
[5] *Chem. Cen.*, 1919, p. 138.
[6] *Ung. Bull.*, 1922, III., 7.
[7] *Amer. Per.*, 1920, p. 365.
[8] *Arch. Neer. Phys.*, 1920, p. 224; *Abs. Chem. Soc.*, 1920, II., 75.
[9] *Ber. Deut.*, 1900, p. 3,401.
[10] *Die syn. und iso. Arom.*, 1899.

[British Science Guild Publicity Service.—Pamphlet No. 2.]

THERMIONIC VALVES.*

By Dr. J. A. Fleming, F.R.S.

Early Discoveries.

In the history and development of the wonderful instrument called the Thermionic valve is to be found a striking example of the important industrial applications that sometimes follow from discoveries which take place in the course of purely scientific researches. In 1883 Edison sealed into the ordinary electric incandescent lamp in use for domestic lighting purposes a metal plate between the legs of its carbon filament. This plate was carried on a wire sealed through the wall of the glass bulb. He noticed that when the filament was made incandescent by a direct current sent through it, simultaneously a small electric current could be observed to be flowing through any delicate current-detecting instrument joined up in a circuit between the *positive* terminal of the filament and the wire carrying the metal plates; on the other hand, when the same instrument was in a circuit between the *negative* end of the filament and the plate, there was no sensible current. This phenomenon was called the "Edison Effect," but no explanation of it was given by its discoverer, nor was any practical use made of it at the time.

Scientific investigations on the nature of this "Edison Effect" were undertaken by me, beginning in 1883, and the discovery was soon made that this effect was connected with the projection in straight lines of particles from the filament. Sir William Preece, in 1885, communicated to the Royal Society a paper on this effect, and there was another paper by me in 1889, in which last it was shown that these projected particles carried a charge of negative electricity and could convey negative electricity from the filament to the plate, but not in the opposite direction. A long paper on this subject was sent by the present author in 1896 to the Physical Society of London.

A further step in advance was made about 1897 by Sir Joseph Thomson, the present master of Trinity College, Cambridge, who, whilst carrying out his remarkable researches in the Cavendish Laboratory, found that the chemical atoms of matter which at the time were thought to be incapable of being divided, were built up of still smaller atoms of electricity, now called electrons, and it was soon definitely ascertained that the incandescent filament of the ordinary electric lamp is continuously sending out a vast number of these little electrons in all directions.

All these achievements were purely scientific, and attracted no popular attention.

About 1897 the application by Senatore

* *Readers of "The Chemical News" will no doubt be interested in one of the practical applications of electrons as apart from their functions in chemical processes. We have pleasure in here publishing "in toto" Pamphlet No. 2, issued by the British Science Guild, being "Thermionic Valves and Their Uses," by Prof. J. A. Fleming, F.R.S.*

Marconi of Hertzian Electric Waves for the purposes of wireless telegraphy began to create public interest. For detecting these waves he first used his improved form of the coherer of Branly and Sir Oliver Lodge. It was, however, rather capricious and somewhat difficult to manage, and Marconi soon replaced it by his magnetic detector in 1901.

INVENTION OF THE THERMIONIC VALVE.

In Marconi's system of wireless telegraphy, the electric waves are generated by creating powerful vibratory currents of electricity in a wire called an aerial wire stretched up through the air. The electric oscillations in this wire produce in surrounding space an effect called an Electric Wave, which travels outwards with the speed of light, viz., 186,000 miles per second. When these waves cut across another similar wire, called a receiving aerial, they create in it feeble electric vibrations of the same type.

In considering this matter, in researches carried out at Unibersity College, London, on Wireless Telegraphy, in 1904, I saw that if means could be found of converting the very rapid to and fro, or alternating, movements of electricity in the receiving circuits into a uniform motion of electricity in one direction, it would then be possible to detect them, and therefore the electric waves, by the use of the telephone or galvanometer as in ordinary telegraphy, without the use of a coherer. The vibrations of electricity in wireless telegraph aerials are, however, bery rapid, even up to a million per second, and none of the devices for "rectifying" or converting slow alternating electric currents into direct currents are of any use. Recalling to mind, however, my scientific investigations on the Edison Effect, I found on experiment that, if a metal cylinder was placed around the filament inside the vacuous bulb of an electric lamp carried on a wire sealed through the bulb, this appliance could "rectify" and therefore detect by the aid of a telephone or galvanometer the feeble high frequency *oscillations of electricity. These cannot* directly affect a telephone, because of their rapid reversals of directions thousands of times per second, but the instrument above described acts as a *valve* when placed in the path of these oscillations, and converts them into motions of electricity in one direction in virtue of the fact that negative electrons are passing in the vacuous space only from the filament to the surrounding metal cylinder.

I therefore named this appliance an *oscillation valbe* and subsequently a *thermionic valve*.

Later, in 1909, I suggested the use of tungsten as the material for the filament in place of carbon, as it withstands a higher temperature and emits more electrons.

The above described two-electrode or hot and cold electrode thermionic valve was soon etensively adopted as a means of rectifying and detecting electric oscillations and detecting wireless waves.

In the spark system of wireless telegraphy then exclusively used, the waves come in little groups of 20 or 30 with longer intervals of time between the groups. The Fleming valve rectifies the groups of oscillations produced in the receiving aerial into short gushes of electricity in one direction, and when these are passed through a telephone they gave rise to a more or less musical sound which can be cut up by a key in the transmitter into *dot* and *dash*, or short and long sounds making signals in the Morse Code.

SUBSEQUENT IMPROVEMENTS.

In 1907 an addition was made to the author's oscillation valve by Dr. Lee de Forest, who had been following in the United States very carefully the work done on this subject. Dr. de Forest introduced into a low vacuum valve a grid or zig-zag of wire between the filament and the plate. This started a new line of development, and it was found that, if a cylinder of metal gauze or spiral of wire was introduced into the hard or high vacuum Fleming Valve between the cylinder and the filament, it enabled the device to act as an amplifier of oscillations as well as a detector, so that very feeble high frequency oscillations could be magnified five or ten times by its aid. This sukgestion was deaeloped practically by the resources of the Western Electric and General Electric Companies of America.

This modified form then became known as a *three-electrode valve*, and is sometimes called for shortness a *triode*, or other trade names. To employ it as an amplified we have to connect a high tension battery giving, say, 40 to 140 volts with its negative pole joined to the filament and its positive pole to the plate. A torrent of electrons is then forced from the filament, through the holes in the grid or gauze to the plate. If,

however, a feeble electrification is given to the grid positive or negative it increases or decreases this electron current. The grid potential electrification can be obtained from any two points on a circuit in which a feeble hikh frequency current flows, and the variation of the plate current of the valve will follow the variations of its grid potential. A number of such valves can be used in series and inter-connected by suitable induction coils or transformers and the plate current variations in one valve made to create changes of grid potential in the next valve. By a series of such coupled amplifying valves. we can then magnify in any required proportion feeble electric oscillations. It is the invention of this detector comprising a series of amplifying valves which has given us a detector of electric oscillations so enormously sensitive that wireless signals can be detected by it at the antipodes of the sending station and enabled us to signal half round the world by its aid.

(To be Continued.)

FLASHING POINTS.

BY FRANK BROWNE, F.I.C.

Attention is drawn to the dangerous nature of highly inflammable liquids of low flashing point, of which class ether, benzol, carbon disulphide, benzoline and petrol are typical. Their flashing points (close test) are between -11° and -30°. Liquids with such low flashing points continuously give off inflammable vapour. The vapour from each is about 2.5 times heavier than air. Consequently, on a warm, still day, this vapour flows from an open tin of the liquid on to the floor, and may be drawn towards a flame situated at a distance of 30 feet by the air current produced by the heat. Then also the heavy vapour may pass through flooring into a danger zone in a room below, or it may flow downstairs. Users and the public, both on land and sea, should recognise these dangerous properties, and take measures accordingly. Where such a liquid is being used there should be no flame within a distance of 50 feet. A store should be ventilated both at top and bottom. Water being useless, a good supply of sand should be available for putting out a fire. Vessels containing these liquids might usefully be labelled "In case of accident, smother fire with sand, earth or cloth."—*(From the "Pharmaceutical Journal,"* 1923, p. 305.)

PROCEEDINGS AND NOTICES OF SOCIETIES.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

A meeting of the Society was held on Wednesday, October 3rd, at the Chemical Society's Rooms. Burlington House, W.

Papers read:—

The Sampling of Coal; the General Problem and some Experiments, by J. H. COSTE, F.I.C., E. R. ANDREWS, F.I.C., and W. E. F. POWNEY, F.I.C.

A New Test for distinguishing Castor Oil, by H. G. STOCKS, F.I.C.

The Volumetric Estimation of Vanadium in Steel, by A.-E. ETHERIDGE, B.Sc., F.I.C., M.B.E.

The Iodimetric Determination of Sugars, by C. L. HINTON, F.I.C., and T. MACARA, F.I.C.

THE CHEMICAL SOCIETY.

ORDINARY SCIENTIFIC MEETING, THURSDAY, OCTOBER 4.

The following papers were read:—

A Revision of the Dissociation Constants of Weak Inorganic Acids. Part I.: Boric Acid, by E. B. R. PRIDEAUX and A. T. WARD.

A Revision of the Dissociation Constants of Weak Inorganic Acids. Part II.: Phosphoric Acid, by E. B. R. PRIDEAUX and A. T. WARD.

Two Heterogeneous Gas Reactions, by C. N. HINSHELWOOD and C. R. PRICHARD.

A Homogeneous Gas Reaction. The Thermal Decomposition of Chlorine Monoxide. Part I., by C. N. HINSHELWOOD and C. R. PRICHARD.

The Direct Union of Oxygen and Sulphur, by R. G. W. NORRISH and E. K. RIDEAL.

Note on Aqueous Formaldehyde Solution, by W. R. ORMANDY and E. C. CRAVEN.

The Interaction of Potassium Tetroxide with Ice and with Dilute Sulphuric Acid, by H. HAWLEY and H. J. S. SAND.

BRITISH DYESTUFFS.

An important letter on the above subject by Prof. W. M. Gardner appeared in the *Yorkshire Post* on September 12, from which the following is taken:—

"At the recent general meeting in Manchester of the British Dyestuffs Corporation (Limited), the Chairman indicated that *the policy of the directors for the present would be not to strive after new discoveries, but to develop the cheaper manufacture of known products. This decision has led to the resignation of the chief research chemist* of the Corporation.

"*It must be recognised that the directors are faced with enormous difficulties.* Their capital charges and production costs are excessively high owing largely to conditions beyond their control; bad trade has greatly reduced the demand for their products in this country, and what export trade there is is subject to the competition of Germany, Switzerland, and the United States. Dye users are strongly urging reduction in prices, and *the shareholders in the Corporation have hitherto received a very meagre return. Under these conditions the directors are bound to adopt* all possible economies which do not militate against ultimate success, and having spent £400,000 on research work during the past four years they propose to curtail such *work in the future.*

"Two questions are involved. Is this policy the correct one; and, if not, what is the defect in the organisation which has led to its adoption?

"With regard to the first point, the past history of the industry is very illuminating. It originated and was developed here for some years, but soon migrated to Germany, mainly because the large profits made were used here as dividends, but in Germany were utilised for research and works development. This fact, and the disastrous consequences of a repetition of the policy, have been pointed out again and again by those who have made a special study of the question.

"*The declared policy of the Corporation seems to be a repetition of the policy of the early sixties, which led to the shipwreck of the* British dye industry in the early days. It is diametrically opposed to the policy which had led to success elsewhere. And, in expending £400,000 in four years on research, the Corporation has only been fulfilling an essential condition. In the successful manufacture of dyes research is as essential as raw material and special machinery, and, appositely enough, the *Board of Trade Journal* of August 30 (p. 216) gives the official figure of 21 million dollars as having been expended on dye research in the United States during the past five years. It is well known, also, that one of the large German colour works, the Badische Co., expended upwards of £900,000 *on research on the synthetic production of indigo alone. Research is the lifeblood of colour manufacture,* and the only wise policy in bad times is to intensify the work, which will lead to the introduction of new and valuable products from which a rich harbest will be reaped. To curtail research is to admit defeat by Continental and American competition. . . ."

GENERAL NOTES.

GERMANY'S POTASH INDUSTRY.

The Commercial Secretary at Berlin (Mr. H. N. Sturrock) has forwarded to the Department of Overseas Trade a report from the *Industrie und Handels Zeitung* of September 5, which states that the year 1922 was a record one for the potash industry, the sales of pure potash increasing from 460,591 tons in 1921 to 647,722 tons in 1922, or 40 per cent. From a report on industry, by the Commerz und Privatbank, it is clear that the enormous increase of potash sales in 1922 was in part due to a covering in advance, having regard to the currency depreciation and to anticipation by customers of a further nominal increase of potash prices. During the first months of 1923, customers showed a certain reserve—a natural reaction after large purchases, and partly due to the anticipated stabilisation of the mark. When it became clear that this could not be maintained, the demand of German agriculture set in on such a scale that in June the highest monthly sales so far recorded by the potash industry were effected, viz., 90,000 tons K_2O. In spite of these large sales, the level of the previous year has not yet been reached, but it is assumed that the difference will be made good during the following months, provided no unforeseen circumstances arise. Foreign countries, in particular, should contribute thereto, as foreign sales in 1923 have so far been satisfactory. The fact must not, however, be lost sight of that difficulties of sale in the potash indus

try would arise immediately if the costs of production were rapidly adjusted to the gold parity, but foreign exchanges were to show a sinking tendency. In such case, the potash industry would doubtless feel the competition of the Alsatian works on the world's market seriously. As before, the American and Dutch markets are the most important customers for German potash.

The income of the industry, measured by distributed profits, is, of course, as in the case of the whole of German industry, extremely meagre, particularly in proportion to the gold capital invested in it.

The present policy of concentration has proved exceedingly successful, and has resulted in a considerable reduction of the costs of production. Only thus has it been possible to keep the inland prices of potash comparatively low, so that the increase as compared with pre-war times is considerably less than in the case of other comparable products of German industry.

PITCH FOR BRIQUETTES.

Mr. R. L. Nosworthy, H.M. Consul at Turin, reports that a local railway company is in the market for a considerable amount of pitch for use in the manufacture of briquettes (mattonelle carbone).

U.K. firms desirous of receiving further particulars regarding this matter should apply to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1, quoting reference 20579/F.W./M.G.2.

INTERVIEWS WITH THE COMMERCIAL SECRETARY AT BELGRADE.

Capt. E. Murray Harvey, O.B.E., Commercial Secretary at Belgrade, will be in attendance at the Department of Overseas Trade on October 1, 2 and 3, for the purpose of interviewing manufacturers and merchants interested in trade with the Serb-Croat-Slovene Kingdom.

Such interviews will only be given by appointment, and applications should be addressed to the Comptroller-General, Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. In all cases the reference 4937/T.G. should be quoted.

BRITISH FLOUR MILLERS' RESEARCH ASSOCIATION.

The Secretary of the Department of Scientific and Industrial Research begs to announce that a licence, under Section 20 of the Companies' (Consolidation) Act, 1908, has been issued by the Board of Trade to the Research Association of British Flour Millers, which has been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research.

The Secretary of this Association is Mr. G. H. Ball, LL.B., 40, Trinity Square, E.C.

NOTICES OF BOOKS.

Practical Chemistry for High Schools, by H. B. Dunnicliff, M.A., B.Sc., A.I.C. Pp. IX. + 279. London: MacMillan & Co., Ltd., St. Martin Street, W.C.2. 1923. 5s.

There are now so many reliable textbooks on practical chemistry that a new publication should possess some outstanding feature to justify its appearance.

In the case of the present volume, which is presumably intended for young students who have not previously studied chemistry, it is difficult to find anything strikingly original in the matter or the presentation of the subject.

Indeed, certain passages might well have been improved upon from the teaching standpoint, and the book leaves the impression of having been hastily compiled.

Certain of the experiments are headed *Demonstrations*, and are apparently to be performed by a demonstrator at the end of the ordinary practical work. It will come as a surprise to most chemists to find that the first experiment for the beginner is the ignition of CS_2!

On page 25, in the section on the use of pipette and burette, quite complicated mathematics (involving the volume of a sphere) is introduced. The reviewer's experience is that even the simplest chemical calculations require careful presentation to young pupils.

Most of the illustrations are good, others, *e.g.*, the distillation apparatus shown on page 17, could be clearer.

The old method of folding a filter paper is shown on page 32, but there is no mention of the modern practice.

On page 67 the author gives several definitions of an acid which he terms incorrect. They are really *incomplete*, and it would have been better to have explained this to the student. In the same chapter the Ionic Theory is dismissed in a few lines, and there is no further reference to ions in the rest of

the book, and not one ionic equation is given.

For some reason, the Qualitative Analysis Tables for identifying metals are duplicated, and this part of the book seems over-burdened with tests and re-actions.

These points, in the reviewer's opinion, detract from the value of a volume which is intended for use in schools. J.G.F.D.

Field Crops in South Africa, by H. D. LEPPAN, B.Sc.A., and G. J. BOSMAN, B.Sc.A. Pp. IX. + 358. Johannesburg: Central News Agency, Ltd., South Africa. 1923. 21s. net.

The time is rapidly approaching when the food production of the world will become a matter of urgent importance.

In his volume, *The Wheat Problem*, published in 1898, the late Sir William Crookes drew attention to the wasteful methods of cultivation and the risks this entailed. Other authorities have also emphasised the need for scientific methods in agricultural practice.

There is, fortunately, increasing evidence of the successful application of scientific methods to crop production, and this is not restricted to Great Britain. The present volume by Messrs. Leppan and Bosman indicates that considerable progress is being made in the Union of South Africa.

The subject of agronomy is treated in its various branches in as comprehensive a manner as possible. The authors have taken into consideration the chemistry, physics and biology of the soil in relation to plant culture. They also indicate the effect of changes in temperature, humidity, air currents, and light upon growth, and devote due attention to the questions of adaptation, breeding, and control of pests. Reference is made to the advances in these various branches of the subject which have been made by the Experimental Stations in South Africa.

The principal summer crops include maize, sorghums, potatoes, lucerne, various legumes, cotton, and sugar-cane. Winter crops include cereals and roots.

By reason of its extremely diversified climatic conditions and peculiar economic factors, agriculture in South Africa presents a great variety of problems. Doubtless considerable progress will continue to be made in the cultivation of those crops most suited to the country.

Those interested in the subject and wishing to consult this important volume can Gordon & Gotch, 15, St. Bride Street, E.C.4.

Alloys Resistant to Corrosion.—A General Discussion. 1923. The Faraday Society, 10, Essex Street, W.C.2. Price 5s. 6d.

Recent Developments in Atomic Theoty, by LEO GRAETZ (Professor of Physics in the University of Munich. Pp. XI. + 174. 1923. Messrs. Methuen & Co., Ltd., 36, Essex Street, W.C.2. 9s. net.

New Patents.

THIS list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Specifications Published this Week.

203013—Thwaite, A. H., and Pease & Partners, Ltd.—Apparatus for drying, grinding, and neutralising sulphate of ammonia in one operation.

203015—Saltrick, W. R.—Extracting and refining metals and alloys.

203051—Soc. of Chemical Industry in Basle.—Manufacture of 2:3-diamino-anthraquinone.

203059—Murdoch, D. G., and Galbraith, W. L.—*Reduction of organic compounds, particularly of nitro and azo-derivatives.*

203124—Petroff, G.—Production of phenol aldehyde condensation products.

181014—Pollak, Dr. T.—Manufacture of condensation products from urea or its derivatives and formaldehyde.

202678—Cocksedge, H. E.—*Process* and manufacture of a sodium compound and a new composition containing the same.

Abstract Published this Week.

200760—Alkali *thiosulphates.—Koppers Co., of* 800, Union Arcade Building, Pittsburg, U.S.A.

Abstract Published this Week.

201302—Synthetic drugs.—Farbwerke vorm. Meister, Lucius, & Bruning, Hoechst-on-Main, Germany.

4-Amino-2- argentomercaptobenzene-1-carboxylic acid is obtained by reacting upon 4-amino-2-mercaptobenzene-1-carboxylic acid with a silver salt. The product, in the form of its alkali salts, is efficacious in the treatment of diseases caused by bacteria; it forms an N-methyl-w-sulphonic acid with formaldehyde and bisulphite, and can be diazotized and coupled with R-salt. In an example the reaction is effected with silver acetate in aqueous acetone containing ammonia; the solution is poured into a mixture of acetone and spirit and the product filtered, dissolved in diluted ammonia and the free silver compound precipitated by *acid; ammoniacal silver chloride, silver fluoride,* or silver nitrate may be used in place of the acetate.

4-amini-2-mercaptobenzene-1-carboxylic acid is obtained by diazotizing 4-nitro-2-amino-benzene-1-carboxylic acid, treating with potassium and cuprous sulphocyanides, and reducing the nitro-sulphocyanobenzene carboxylic acid.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d.

THE CHEMICAL NEWS,

VOL. CXXVII. No. 3313.

IS THERE AN ELEMENT OF ZERO ATOMIC NUMBER?

PART IV.

By F. H. LORING.

In continuation of the above subject—*The Chemical News*, 1923, CXXVI., pp. 307, 325, 369—attention may be drawn to another line of study, but before proceeding with this development, it is considered necessary to refer to an abstract of the first two papers, which appeared in *Science Abstracts* for September, page 618, as follows:—" It is suggested that a single electron might be regarded as representing an atom with atomic number zero, since *the atomic number represents the number of protons in the atom*, and a single electron of course contains no protons." The italics are the present writer's. Continuing the quotation in order to refresh the mind of the reader as to the general scheme of arrangement involved in the argument—" If the existence of an active element with atomic number zero is assumed, and if the number of active elements below each of the inert gases is subtracted from its atomic number, the series 0, 1, 2, 3, 4, 5 is obtained, &c."

Now it was not the writer's intention to convey the idea that the atomic number was exactly represented by the number of protons in the atom, as obviously the existence of isotopes on first thougnt renders such an idea impossible; in fact it was explicitly stated that the electrons in the nucleus of the atom conditioned it in terms of atomic number—see bottom of page 325 *et seq.* (See also Aston's "Isotopes," pages 106, 107.)

It is evident, however, that the existence of sub-atoms of zero atomic number of mass 1 might bring about such a state of affairs, and no doubt the abstracter gathered this idea from the argument as presented. This view becomes an interesting possibility, but it will suffice merely to call particular attention to it here.

In *The Chemical News* of July 26, 1912, vol. CVI., p. 37, the present writer showed that the periodic table could be partitioned into a *series of 5 natural* groups, as follows: Inert gases; Group VIII.; Group Pr to Lu; Grouping Cu, Ag, Au, to Br, I, —; The remaining elements.

The numbers of elements in these respective groups and groupings were given as 8, 9, 13, 20 or 21, 43, the sum being 92.83 by a formula given for calculating them. This was in 1912, before the atomic numbers were known. Had the atomic numbers been known at the time, the radio-elements would have been fully included in the scheme. The term *element* is now used in the atomic-number sense in discussions of this kind.

If now an element of zero atomic number is introduced at the head of the inert gases, it could, of course, be the electron as an element in one sense, for, like the inert gases, its atoms do not appear to combine with themselves, since they (the electrons) repel each other: but they are in other ways active.

Another view is, however, possible, and that is to consider an element of neutral property as if an electron had combined closely with a proton. This was discussed in Part III. (p. 369) of this series of papers. This will be referred to again below.

It will be seen from the foregoing that there should be 7 inert gases; 9 elements of Group VIII.; 13 elements of Group III. after cerium, generally referred to as the rare-earth series (extended series to be more precise); 21 elements, of which Cu, Ag, Au, are the left-hand members; and finally, 43 elements, the left-hand members of which are the alkali elements and including hydrogen and those of atomic numbers 72, 73, 74, 75, 87, 88, 89, 90, 91, 92.

Of course, some of the elements now represented by gaps may exist in very small relative quantities, as already discussed in these pages—see *The Chemical News*, 1922, vol. CXXV., pp. 309, 386; 1923, vol. CXXVI., p. 1.

Considering another cognate matter, coronium is known in the sun, but it is not known on the earth, so that it is in the nature of events to expect future discovery in this connection to throw some light upon the problems here discussed.

To show the trend of modern thought, the following, from page 157 of a new book just published, *Recent Developments in Atomic Theory*, by L. Graetz, translated from the German by G. Barr, is of interest in relation to these matters. In this exposition, Rutherford [see the writer's *Atomic Theories*, pp. 48, 49] remarks that it is possible that two hydrogen nuclei [protons]

with one electron might form the nucleus of another atom, which would then have a mass 2 and a nuclear charge 1, so that it would be an isotope of hydrogen. But there might also be a structure, consisting of a hydrogen nucleus and a negative electron, in which the electron was not, as in the hydrogen atom, at a great distance from the nucleus but directly adjacent to it. Such a structure would be electrically neutral except in its immediate neighbourhood. At the same time it would have a certain linear shape, and would orient itself in a definite direction in a magnetic or electric field. The possibility is not remote that what we call æther—which is, as is well known, a very bugbear in physics—might perhaps consist of such a doublet. The linear extension of this structure [lines of force?] would in particular afford an explanation of the fact that æther propagates electric and magnetic disturbances in the form of transverse vibrations. It would then also be conceivable, according to an idea of Nernst's, that under certain circumstances hydrogen atoms might be generated out of the æther, or, conversely, hydrogen atoms might be absorbed into the æther. Lodge (*Nature*, Aug. 4, 1923) has suggested that electrons are generated and absorbed in a similar way, involving the transformation of the energy of radiation. This is, of course, speculation, but there are many phenomena known to-day which make such ideas worth serious study.

The following points may be noted in connection with this study:—

1.—5 main groupings represented by the number of elements in each one.

2.—There may be 7 inert gases or members of the first group of this series, thus:

Rn, Tn, An (emanations)	At.	No.	86	(1)
Xenon	,,	,,	54	(2)
Krypton	,,	,,	36	(3)
Argon	,,	,,	18	(4)
Neon	,,	,,	10	(5)
Helium	,,	,,	2	(6)
Zero Element?	,,	,,	0	(7)

3.—The other numbers, 9, 13, 21, 43, are, together with those above (7), in additive agreement with the atomic-number series; and they all stand in the right order as regards average chemical activity.

4.—The probable fact that there will be some gaps in the periodic table which will never be properly filled is in agreement with the "place principle" involved in the Bohr-Rutherford atom theory; and in constants as herein evaluated include such gaps. Nothing is in conflict, however, with the atomic-number-series classification of the elements in any of these studies.

5.—The three inert radio-active gases are isotopic, but each one being inactive chemically this isotopic character rests only on atomic number, so one is tempted to raise the figure to 8 or 9, according as the "zero element" is included or not, but the balance of the evidence seems to favour the lesser number, 7.

6.—The question whether the zero member can be an atom of æther, or the electron, or a close combination of a proton with an electron, or perhaps the element coronium, makes the subject an intensely interesting one.

[British Science Guild Publicity Service.—Pamphlet No. 2.]

THERMIONIC VALVES.*

By Dr. J. A. Fleming, F.R.S.

(*Continued from Page* 221.)

The Thermionic Oscillation Generator.

The thermionic valve in its two and three-electrode forms possesses the power not only of rectifying and detecting electric oscillations, but also of creating so-called continuous or undamped oscillations. This discovery at once rendered possible radio-telephony on a large practical scale, whereas it had previously only been an occasional feat of experts. The proper coupling through a transformer of the grid and plate circuits results in the production in these circuits of self-sustained oscillations by energy drawn from the plate circuit.

During and since the war, improvements have continually been made in the construction of large generating valves. Beginning originally with very small powers of a few watts in valves with bulbs like incandescent lamps, very large valves in glass bulbs the size and shape of Rugby footballs, yielding an output of 6 or 7 kilowatts, are now made. Valves of 10—20 kilowatts ut-

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* *Readers of "The Chemical News" will no doubt be interested in one of the practical applications of electrons as apart from their functions in chemical processes. We have pleasure in here publishing "in toto" Pamphlet No. 2, issued by the British Science Guild, being "Thermionic Valves and Their Uses," by Prof. J. A. Fleming, F.R.S.*

t or more have been made with bulbs of ica. The most recent advance in this di- tion has come to us from the United ates. A method of making high power ives with pulbs partly of glass and partly copper has been developed by the West- 1 Electric Company of America, based the fact that a copper tube with a sharp ge can be welded to a glass tube. In ge valves a source of trouble is the heat- of the metal cylinder by the bombard- ent of the electrons. In the metal bulb lves the copper part forms also the anode linder, and it can be kept cool by immer- n in water. Large generating valves of to 100 kilowatts have been made in this anner, and the General Electric Company America are said to be preparing a ther- ionic generating valve of the two elec- ode or Fleming type with an output of 000 kilowatts, or 1,300 horse power. If is can be done, large thermionic valves ill replace high frequency alternators en- ely in long distance wireless stations. lready Marconi's Wireless Telegraph ompany have a Valve Panel of 56 large ass valves in their Carnarvon Radio Sta- on with which communication is made rect to Australia. The present public ireless Telephone broadcasting stations in reat Britain employ large valve generators their transmission plant.

Modern Wireless Telephone and Telegraph Valve Receivers.

The improvements made in the construc- on of the thermionic valve and the close udy of its action imposed by the neces- ty for developing wireless telegraphy and lephone during the great European War ave given us an extraordinarily sensitive nd easily managed detector of electric aves, and the advent of wireless telephone roadcasting has created a novel trade in he manufacture of these valves for generat- ng, amplifying and detecting electric aves.

In the receiving valve most commonly sed, a straight filament of tungsten, or horiated tungsten, or else platinum- idium, coated with oxides of barium and trontium, is used. This is surrounded by spiral wire forming the grid and by a ickel or molybdenum cylinder forming the late. The ends of the filament, grid, and late are connected to pins on a cap so that he valve can fit into a socket like an elec- ric lamp.

In modern wireless telegraph receivers, one or more valves are used to amplify the oscillations; one to detect, and one or more to amplify the rectified currents.

Valves of this type were made to the number of three or four million during the war (1914—1918), and are manufactured now by the hundred thousand per annum for wireless broadcasting purposes. Large factories employing hundreds of workers are devoted to their manufacture.

The Thermionic Telephone Repeater.

An additional great service the ther- mionic valve renders is as a perfect tele- phone relay or repeater. Telephone elec- tric speech currents are enfeebled by flow- ing along a telephone wire, and for long dis- tance working very thick and therefore costly wires were required. Thermionic amplifyers can, however, be inserted in the run of line to re-enforce the currents so that they start on a further journey with fresh strength. By the use of these repeaters, telephonic speech is now transmitted right across the Continent of America (4,000 miles), and they are being now much used by the British Post Office. For shorter dis- tances a great economy in copper can be obtained by their use. It would be feasible to speak from London to Delhi if it were worth while to erect the line and repeater stations. In short, the thermionic valve has effected a revolution in ordinary tele- phony just as it has made possible wireless telephony.

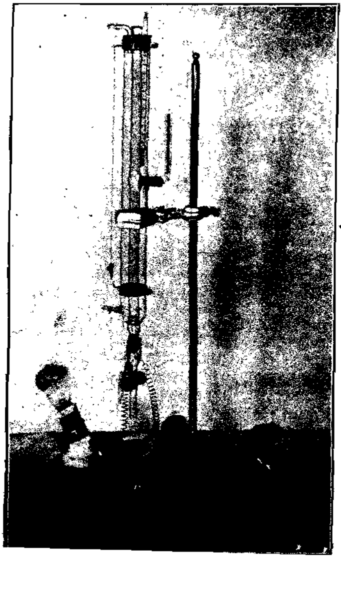
Conclusion.

It will be seen, therefore, that out of purely scientific researches and discoveries by Edison, Fleming, J. J. Thomson, Irv- ing Langmuir, Lee de Forest, the invention of the two-electrode thermionic valve by the author in 1904 and the subsequent de- velopment of these discoveries by the ex- pert investigators of great commercial or- ganisations such as the Western Electric, The General Electric, The Marconi Wireless Telegraph, The Osram Lamp and Edison Swan Electric Lamp Companies, an im- mense industry has been built up, which, starting from very small beginnings when the first Fleming valves were made at the Edison and Swan Electric Lamp Works in 1904, and the Steam Electric Lamp Works, England, in 1907, has attained now (1923) enormous proportions and created an in- dustry which has yet a great future before

A RELIABLE APPARATUS FOR THE RAPID ANALYSIS AND REGULATION OF HIGHLY VISCOUS SUBSTANCES.

By Dr. Gustav F. Dierfeld.

Hitherto there has been a considerable lack of apparatus for quickly analysing and regulating the application of highly viscous substances like varnishes for graphic purposes, lacquers, tar products, varnishes composed of pitches and oils, glue gelatines, collotions, etc. Analyses of this kind were generally performed by feeling or touch, whereby many mistakes took place, and a required correction could not be effected in a quick and reliable manner resting on calculation, and very troublesome difficulties and loss of time and money could be incurred in the course of further working. Dr. Robert Fischer, jointly with the Franz Hugershoff-works in Leipzig (Germany), has now designed a very cheap, easily heated apparatus, making possible a thoroughly reliable and exact analysis of highly viscous transparent and opaque sub stances within the shortest time and und variable conditions.



This apparatus consists of an extern glass tube, a cooling apparatus containing thermometer, has a plumb-line on one side and is supported by a stand (see the figure) Within the outer glass tube a narrowe one is arranged, open at its upper end an provided at its lower end with a cock and a its right side with a short glass tube shape like an elbow, that contains another the mometer and leads through the surroundin external glass tube: A contact device a ranged in the inner tube a little above th cock may be connected with an incande cent lamp or electric bell, jointed with a electric lead. For testing a viscous su stance, the apparatus is at first adjusted b means of the plumb-line and the adjustin screws of the stand, so that it has an exact vertical position. Then the external tu is filled up with water at 70° S. (158° Fahr that is cooled down to 62° C. (143.6° Fahr. The temperature of this heating liquid observed by means of the thermometer, a ranged in the external tube or cooling a paratus, which makes a uniform heating the apparatus possible by means of a co stant supply of warm water. Meanwhil about 100 grams of the substance to tested (*e.g.*, glycerine) are warmed up 70° C., and a sufficient quantity of th liquid is poured into the inner tube fro above up to the destined stroke, and cooled down to 58° C., as indicated by t aid of the thermometer in the elbow-li short glass tube. As stated, the differen of temperature of 4° C., and the temper ture of the liquid to be tested of 58° C., always the same. A small ball of al minium or brass is then let fall through t upper open end of the inner tube; this tu is enlarged at the spot of its wall, oppos to the elbow-like glass tube, so that th ball is not turned from its proper way. I means of a stop-watch the time of falling the ball in the liquid up to the lying on t contact device is determined. This tir amounts to 4 seconds with glycerine of known quality used generally as gaugi liquid for gaining a decided footing. Tl value, 4, is the unit for the temperatu 62°-58° C.

Another substance, showing at the sa difference of temperature with a time falling of 16 seconds for the same ball, h a viscosity of 4, compared with the abo *i.e.*, its viscosity is four times greater.

alling ball touches the contact device, the amp lights up or the bell rings, and at this noment the stop-watch should be read. In ery thin or diluted liquids the time of falling of the normal ball may be so little that nistakes of observation may occur, and nay cause a considerahle error. To avoid his and to increase the time of falling by a nultiple, Dr. Fischer utilised small balls of lifferent size, three of aluminum and three of brass—according to the less or greater iscosity of the substances to be tested. Of course, in such cases, the apparatus is o be specially gauged for each of the balls.

Whilst a bright, transparent liquid is ested in such a manner whereby the falling of the ball is distinctly visible for examining dark-coloured, opaque substances, the pparatus is connected with the incandesent lamp or electric bell; as soon as the

From this work it is possible to compile ables, containing the numbers for different nixtures, for the adjusting of lacquers, arnishes, etc. A single number is then ufficient for showing full particulars of the iscosity of each substance. This proedure is more reliable than the usual one or samples of different substances, which requently transform or deteriorate in the ourse of time. As admitted by experts, his apparatus of Fischer's has been used ith success for the most varied industries.

ORGANIC MERCURY COMPOUNDS.

Part III.

By R. F. Hunter, F.C.S.

(Continued from Page 217.)

We have now to consider the derivatives f phenols and related compounds, derivaves of aromatic ketones and terpenes, de vatives of aromatic acids, and lastly, the erivatives of heterocyclic compounds.

The first to be considered are the phenol, apbthol derivatives, etc.

o Chloromercuri phenol.—The first typial compound is usually prepared along ith the m and p compounds by the action f mercuric acetate on phenol. It reacts ith nitrous acid to yield p nitroso chloroercuri phenol. Other phenol derivatives re:

p Acetoxy mercuri phenol;
p Chloromercuri phenol;
p Hydroxy mercuri phenol;
Di-acetoxy mercuri phenol;
p Benzeneazo o acetoxy mercuri phenol o and p dichloromercuri phenol;
Mercuri bis o phenol;
Mercuri bis o phenylacetate;
Mercuri bis p phenylacetate.

Phenol ethers readily react with mercuric acetate, for instance, anisole has derivatives, such as:

o Mercury Dianisyl;
o Acetoxy mercuri anisole;
p Mercury dianisyl.

With mercuric acetate anisole yields such compounds as p acetoxymercuri anisole.

o Mercury diphenetyl, o acetoxy mercuri phenetole, p mercury diphenetyl are derivatives of phenetole.

Phenetole heated with mercuric acetate yields p acetoxy mercuri pheuetole.

As examples of mercury derivatives of substituted phenols we have:

p Hydroxymercuri o chlorophenol;
o Hydroxymercuri p chlorophenol;
4 Hydroxy mercuri 2 nitro phenol;
4 4′ Mercuri bis 2 nitro phenol;
2 Hydroxy mercuri 4 nitrophenol;
2 Acetoxy mercuri 4 nitrophenol;
2 Chloromercuri 4 nitro phenol;
Hydroxy mercuri picric acid;
Chloromercuri picric acid.
p Chloromercuri o aminophenol;
6 6′ Mercuri bis 1 hydroxy 2 methyl henzene;
4 arsenic acid;
o Acetoxy mercuri p cresol;
o Iodomercuri p cresol;
Diacetoxy mercuri p cresol;
o Chloromercuri p cresol methyl ether.

As derivatives of the naphthols we have 4 acetoxy mercuri α naphthol prepared from the action of naphthol in mercuric acetate in acetic acid solution;

2, 4 Diacetoxy mercuri α naphthol;
1 Acetoxy mercuri β naphthol;
2 Acetoxy mercuri 1 naphthol 4 sulphonic acid and its sodium salt.

Derivatives of resorcinol have been prepared, for instance:

Chloro mercuri resorcinol;
Dichloro mercuri resorcinol;
6 Acetoxy mercuri 2 nitro resorcin.

The first mercury derivatives of the aromatic acids to be considered are those of benzoic acid and the anhydride of o hydroxy mercuri. Benzoic acid is typical, and is prepared by fusing mercuric acetato and benzoic acid until the reaction is complete.

Derivatives of benzoic ester are:

o Chloro mercuri benzoic methyl ester;

and o Chloromercuri benzoyl chloride.

As derivatives of substituted benzoic acid we have:

N - iso di acetoxy mercuri anthranilic methyl ester;

Ac O Hg C_6H_3 (CO_2 Me) N H Hg O Ac H_2 O;

Acetoxy mercuri anthranilic methyl ester;

Iodo mercuri anthranilic acid;

5, 5′ Mercuri bis 2 amino benzoic methyl ester;

6, 6′ Mercuri bis 2 amino benzoic acid;

Chloromercuri methylanthranilic methyl ester;

Iodomercuri methyl anthranilic acid;

Acetoxy mercuri p amino benzoic ethyl ester.

The derivatives of cinnamic and salycilic acid deserve mention. Examples of the former are:

a Acetoxy mercuri β methoxy hydrocinnamic methyl ester;

a Mercuri di β phenyl anhydrohydracrylic acid;

a Acetoxy mercuri β ethoxy hydrocinnamic methyl ester;

a Acetoxy mercuri β isopropopy hydrocinnamic methyl ester;

and of the latter case:

3 Halide mercuri 2 hydroxy benzoic acid;

Chloromercuri salicylic methyl ester;

Acetoxy mercuri salicylic methyl ester;

Mercuri bis salicylic ethyl ester;

3 Acetoxy mercuri 5 nitro salicylic acid;

5 Amino salicylic acid

are examples.

The derivatives of ketones and terpenes are not of great importance. We might mention:

Phenacyl mercuri chloride;

Phenyl o chloromercuri phenyl ethyl carbinol;

2 Hydroxy mercuri indandione as ketone derivatives.

2 Chloro mercuri cineol is an example of a terpinecol derivative. As camphor derivatives we have:

a a Di iodomercuri camphor;

a Acetoxy mercuri camphor; and

a Halide mercuri camphor.

We have now to consider our last group of compounds, viz., the mercury derivatives of heterocyclic compounds.

Thiophene in acid solution reacts with the sulphate of mercury, giving a series of compounds.

Chloromercuri thiophene is obtained from thiophene in alcohol, saturated mercuric chloride and concentrated sodium acetate solution. It reacts with halogens acid halides, inorganic iodides, etc.

Other thiophene derivatives are:

a Iodo and bromo mercuri thiophene;

a Mercury di thienyl.

As derivatives of substituted thiphene we might mention:

5 Chloro mercuri 2 methyl thiophene;

5, 5′ Mercuri bis 2 chloro thiophene;

5, 5′ Mercuri bis 2 iodothiophene;

3 Chloromercuri 2, 5 dimethyl thiophene

2, 5 Dichloromercuri 3 methyl thiophene

2, 2′ Mercuri bis 3, 4 dimethyl thiophen

Among the compounds of this grou which have been prepared, we have deriv tives of indole, pyrapolones, for instance:

3 Methyl, 3, 4 diacetoxy mercuri 4 meth oxy 1 acetoxy mercuri phenol 3, 4 dihyd 5 pyrazolone is a pyrazolone derivativ Cyclomercuri polymethylenes are said have been prepared.

The mercury compounds have been r viewed. Anything like a full review is in possible in an article such as this. Th field is a very big one, to say the least of No attempt has been made to describe t preparations. These can be found in Wh more s excellent work and in the origin papers. As with arsenic, compounds lesser importance have sometimes be mentioned where more deserving ones ha been omitted. This is inevitable in article of this kind, but nevertheless, if t article has brought the subject to the noti of many chemists who have not previous had to deal with the subject, I shall fe satisfied. Again, as I said before, t article is a review, not a thesis, and a r view, like charity, can be made to "hide multitude of sins," and this being so I not feel called upon to apologise for its i completeness, and in many places, lack experimental detail.

PRELIMINARY REPORT OF THE MINERAL PRODUCTION OF CANAI DURING THE SIX MONTHS ENDII JUNE 30, 1923.

The present report is issued in contir ance of the policy of the Dominion Bure of Statistics of preparing preliminary es mates regarding the production of the pr cipal mineral products from Canadian posits. Data are given showing the qu tity and value of each metal produced a of each non-metallic mineral shipp

Comparative figures are given for the corresponding period of the previous year and revised statistics for the calendar year 1922 have been included.

Measured in terms of the metallic and non-metallic mineral output and excluding structural materials and clay products, the mineral production of Canada during the six months ending June, 1923, was valued at $87,152,248, as compared with $60,361,109, the value of the corresponding production in the first six months of 1922. The output of these commodities during the twelve months of the calendar year 1922 was valued at $144,762,501, so the records for the present year show that an appreciable advance has been made both in relation to the output in the first six months of 1922 and also to the entire calendar year.

The outstanding feature of the metal industry was the recovery in the production of nickel and copper. The re-opening of the smelters and refineries operated by the International Nickel Company and the British America Nickel Corporation resulted in a production of nickel during the first six months of the year which was nearly seven times graeter than the production in the first half of last year, and the output of copper was more than double the quantity produced in the corresponding period last year. The copper output during the half-year was greater than the total production during the calendar year 1922; the nickel output was also nearly 60 per cent. greater than the entire quantity made during the twelve months ending December, 1922.

The production of gold and silver was maintained at about the same levels as in the corresponding period in 1922, while the outputs of asbestos, coal, lead and zinc were higher than in the first half of 1922. Shipments of gypsum, while less in amount were greater in value, and while the output of salt declined the quantity sold was greater than in the half-year ending June, 1922.

Power shortage was again experienced in Northern Ontario during the spring months, and it was not until the latter part of April and the beginning of May that enough power was obtained to permit capacity operation of the Porcupine mines. The three leading producers were reported early in May as being in a position to treat approximately 7,000 tons of ore, the Hollinger treating about 5,000, the Dome 1,200, and the McIntyre 1,000. The operation of the enlarged McIntyre plant was also made possible by the additional power obtained about the beginning of May.

Power developments in Northern Ontario have been watched with considerable interest by the mining industry. Sturgeon Falls power is now available; Metachewan is expected to be operating by fall, and the developments on the Quinze River and by the Hollinger on the Abitibi River are being carried forward with a view to the elimination of the recurring spring power shortage that has handicapped these properties up to the present time.

GENERAL NOTES.

METAL FOR SYNTHETIC AMMONIA TUBES.

The tubes which contain the catalyst for synthesis of ammonia must support the action of compressed gases at temperatures of 500 to 700° C. They have been made with alloys poor in carbon and containing nickel, chromium, tungsten or similar metals. The percentage of nickel may be 60 per cent. and more. According to a French invention by the Société Chimique de la Grande Paroisse a very soft iron, poor in carbon, can be utilised for hyper-pressure treatment. The composition of the iron is similar to that of dynamo and transformer plates. A metal employed for the purpose contained: Si, 0.018 per cent.; S, 0.09 per cent.; C, 0.098 per cent.; Mn, 0.93 per cent.

Thin round plates of this metal were subjected for hundreds of hours to the action of a mixture of N, H and NH_3, at a pressure of 1,000 atmospheres and temperatures varying from 700° to 800° C., without displaying any sign of fragility. Such a metal can be employed for catalyser tubes, provided that suitable measures are taken to provide for the considerate decrease in tensile strength and the appearance of viscidity at temperatures above 500° C.—(*L'Industrie Chimique*, August, 1923.)

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE CHEMICAL SOCIETY.

The following papers were read at the Ordinary Scientific Meeting, Oct. 4:

Note on Aqueous Formaldehyde Solution, y W. R. Ormandy and E. C. Craven.

Discrepancies in the published values for ie densities of aqueous formaldehyde solu- ions probably arise from the presence of ıethyl alcohol. The densities of solutions repared by refluxing with water are now ound to agree excellently with the results f Auerbach and Barschall, who prepared olutions by volatilising paraform in a cur- ent of nitrogen and absorbing the gaseous ormaldehyde in water. The density and he refractive index of a formaldehyde olution appear to be linear functions of the ormaldehyde concentrations.

The specific refractivity of the formalde- yde in the dilute aqueous solution appears o be 0.205, which agrees well with the as- umption that methylene glycol is formed, nd this is also borne out by density ıeasurements.

The interaction of potassium tetroxide ith Ice, and with dilute Sulphuric Acid, y H. Hawley and H. J. S. Sand.

It was shown that only hydrogen dioxide esults from the interaction of potassium etroxide with ice or with dilute sulphuric cid.

The Direct Union of Oxygen and Sulphur, y R. G. W. Norrish and E. K. Rideal.

The reaction of oxygen and sulphur has een studied by a dynamic flow method, be- ween 235° and 385°. Below 305° it pro- eeds with a temperature coefficient of 1.63; bove 305° this falls off rapidly, due to the econdary formation of sulphur trioxide. he reaction is limited to the surface of the ılphur and the walls of the vessel, and roceeds equally well on both, pointing to a quid film covering the whole surface of ıe vessel.

A table of seven different reactions of sul- hur was given, which shows that their cri- cal increments are simple multiples of a onstant quantity, which is considered to be ıe half value of the work required to create ne free sulphur bond.

Prof. J. F. Thorpe also read two papers ealing with the work of himself and his ollaborators in the field of Isomerism and automerism.

THE INSTITUTE OF METALS.

Programme for 1923-24.

The Institute of Metals has just issued its programme of meetings and lectures for the session 1923-24. There are over thirty lectures and addresses to be given before the Institute's local sections in Birmingham, Glasgow, London, Newcastle-on-Tyne, Sheffield, and Swansea, as well as at meetings of the parent Institute, one of the latter, including a lecture by Dr. F. W. Aston, F.R.S., which is to form part of the proceedings of next year's Empire Congress of Mining and Metallurgy.

The subjects of the lectures are of a character to interest engineers and metal workers, and include "Extrusion Problems," "Nickel Brasses," "Some Impressions of American Non-Ferrous Metallurgy," "Metals for Lamp Manufacture," "X-Rays and Metallurgy," "General Scientific Brass Foundry Work," "Alloys for use with Super-heated Steam," "The Density of Alloys," "The Annealing of Non-Ferrous Metals," "The Action of Molten Brass on Nickel Steel," "Propeller Brass," "Large Metallic Crystals and Some of their Properties," "The Cold Working of Metals," "Electric Resistance Furnaces," "Substitutes for Platinum," "The Metallurgical Microscope," and "Influence of Casting Temperature on the Physical Properties of Metals."

A ballot for the election of members of the Institute (whose membership covers that of the local sections), is due to take place shortly, and full particulars can be obtained from the Secretary of the Institute, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Recent Researches Bearing upon the Origin of Petroleum, by E. H. Cunningham-Craig, B.A., F.R.S.E., F.G.S. (Member).

Read at the Royal Society of Arts, on Tuesday, October 9.

The author dealt with some of the researches which have been undertaken, having a distinct bearing upon the origin of petroleum.

The genesis of petroleum has been variously attributed to:—A. Inorganic Origin: (1) Hypogene causes; (2) Vulcanicity. B. Organic Origin: (1) From animal matter; (2) From vegetable matter.

Of the inorganic origin there is little to be said.

This leaves the organic theories as rivals, that of animal origin being chiefly supported by chemists, while the vegetable origin theory is largely held by geologists, and has gained much ground in recent years.

There is a tendency to investigate the relations of coals and lignites to petroleum. Every country that contains either coal or petroleum, or both, can furnish some evidence, and it is becoming obvious that the two fuels have definite relations to each other.

The three main oil-bearing horizons in Trinidad have each a carbonaceous phase in some other district, and the two phases, petroliferous and carbonaceous, approach each other very closely in some localities.

Similar evidence has been forthcoming from many countries, *e.g.*, Venezuela, Burma, Assam, Hungary, and Roumania.

Much pertinent evidence from Great Britain was also brought to light by the work of the Petroleum Research Department during the war, but unpublished, and the relations of oil to coal and to oil-shale have been made clearer. Perhaps the most striking evidence is that afforded by the boring at D'Arcy, near Kalkeith. This well was drilled on the theory that oil-shale denotes petroleum that is dead and buried, but that beneath an oil-shale series some free petroleum may still exist.

By treating any coal containing a fair percentage of volatile matter with hydrogen under very high pressure and at temperatures up to 850° F., a remarkable exothermic action is induced and a portion of the solid fuel becomes liquefied, giving as a result a product indistinguishable from heavy crude petroleum. Similar effects can be obtained by hydrogenating heavy crude oils, lighter oils being formed. The work of Dr. Bergius, though perhaps hardly yet successful as a commercial proposition when coal is treated, or, as it is stated, "liquefied," has certainly opened up a vista of great possibilities. It appears that the percentages of volatile matter in the coal is one of the determining factors controlling the reaction, another being the pressure. Pressures as high as 3,000 and even 5,000 lbs. per square inch have been used, but action may commence with a pressure of no more than 600 lbs. Temperatures need not apparently be very high, but as the action is exothermic there is difficulty in keeping it from rising too high. The reacton takes place in an autoclave.

The value and importance of these researches lie in their similarity to the conditions of the formation of oil. It has long been recognised that coal is a finished product, and that oils cannot be formed from it except by distillation.

The fact that the reaction is exothermic must not be lost sight of. External heating of the autoclave will retard the action, and the heat engendered by the action may be sufficient to check it and bring about an equilibrium. But in Nature, working slowly through countless periods of time, the rapid heating up of the material by an exothermic reaction will be obviated by conduction.

Prof. Flynn recently separated gels from the matrix by crushing a Nova Scotia torbanite and floating the gels in brine, so that they can be examined and analysed apart. The gels are tough rather than hard, and so resist crushing successfully; they are of large size and rough exterior, and are fresh and free from signs of inspissation. They contain from 16 to 20 per cent. of inorganic matter in a fine colloidal state. The inorganic content is quite conclusive proof that these gels are not vegetable fossils. This confirms the views advanced by the writer, and if oil shale denotes petroleum petroleum "still-born."

THE OPTICAL SOCIETY.

An Ordinary Meeting of the Society was held at the Imperial College of Science and Technology, Imperial Institute Road, on Thursday, October 11. The following papers were read and discussed:—

Notes on the Elementary Algebraic Theory of a Class of Photographic Objectives, by E. T. HANSON, B.A.

A General Survey of the Thin Double Lens, by T. SMITH, M.A., F.INST.P.

New Types of Levelling Instruments using Reversible Bubbles, by T. F. CONNOLLY, M.Sc.

JOURNAL OF SCIENTIFIC INSTRUMENTS.

The first regular monthly number of the *Journal of Scientific Instruments* produced by the Institute of Physics with the co-operation of the National Physical Laboratory, will appear on October 15.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

ORDINARY MEETING.

Held at the Chemical Society's Rooms, on October 3.

Mr. P. A. Ellis Richards, President, in the chair.

Certificates were read for the first time in favour of:—

Messrs. Laurence Eversley Campbell, M.Sc. (Lond.), F.I.C.; John Troubridge Hannon, B.A. (Cantab), A.R.C.Sc., A.I.C.; Cyril Langley Hinton. F.I.C.; Douglas William Kent-Jones, B.Sc. (Lond.), F.I.C.; Thomas William Alan Shaw, M.Sc. (Liv.); William Hall Simmons, A.I.C.; Kenneth Edward Nethercoate Williams; Percy Noel Williams, M.Sc. (Liv.), A.I.C.

The following was elected a member: Mr. Robert C. Grimwood, A.C.G.F.C., D.I.C., A.I.C.

The following papers were read:—

The Sampling of Coal: the General Problem and some Experiments, by J. H. COSTE, F.I.C., E. R. ANDREWS, F.I.C., and W. E. F. POWNEY, F.I.C.

Attention was drawn to difficulties encountered in sampling coal which is often a heterogeneous mixture, and in consequence of which the variations in composition of different "patches" are extremely wide. These variations are likely to be more extreme in those cases where the bulk is large and where it is impossible to sample throughout the dump.

General considerations that should govern the sampling were suggested, and stress was laid upon the point that if, as often happens, different workers obtain different results from samples taken from the same bulk, the discrepancies are not due to mistakes in working, but were indicative of the variability in composition of the coal. Experiments were described in which (1) it was shown how difficult it is to obtain a homogeneous set of samples from so small a quantity of coal as 70-80 lbs., and (2) the variation in composition of samples taken progressively from a bulk of about 400 lbs.

New Test for Distinguishing Castor Oil from other Oils and determining its Purity, by H. B. STOCKS, F.I.C.

Ordinary soap solutions are alkaline to phenol-phthalein. On titration with standard acid solution a point is reached at which a state of equilibrium exists and the pink colour disappears. The amount of acid required increases with the dilution up to about 1 part in 150 or higher, at which point it becomes practically constant. With soaps of oleic, palmitic, and stearic acids, and soaps from oils composed of these acids, the figures are equivalent to approximately half the total combined alkali. With castor oil soap it is only 3 to 11 per cent. of the total. 5 grams of the oil to be examined are saponified with alcoholic potassium hydroxide, neutralised, evaporated to remove alcohol, made up to 100 ccs., 10 ccs. being diluted with 250 ccs. of neutral distilled water and titrated with hydrochloric acid in presence of phenol-phthalein. Castor oil gave figures varying between 4.8 and 7.9, and figures are given in the paper for a number of fats and oils and rosin, in each case very much higher than for castor oil.

The Volumetric Estimation of Vanadium in Steel, by A. T. ETHERIDGE, B.Sc., F.I.C., M.B.E.

The estimation is carried out in the same solution in which the chromium has already been estimated by treating the aqueous solution of the sulphates of the metals with permanganate, filtering, removing any colour due to iron, treating with standard ferrous sulphate solution and titrating with permanganate. This gives the chromium figure. The solution is then adjusted so that it contains about 10 per cent. by volume of sulphuric acid, excess of ferrous sulphate is added, and the solution titrated with potassium bichromate, using as indicator 5 cc. of diphenyl carbazide prepared by dissolving 0.5 grams in 1-2 cc. glacial acetic acid, and diluting to 500 cc., and adding to each 5 cc., 3 drops of 25 per cent. sulphuric acid, and 1 drop of potassium bichromate solution, resulting in the formation of a deep purple colouration. About half the indicator solution is then added and the end point occurs within 1 or 2 drops, with the formation of an apple green tint. It is necessary to have (1) a small amount of ferrous solution present at the time the indicator is added, (2) 10 per cent. sulphuric acid, (3) absence of nitric acid (except in traces).

The Iodimetric Determination of Sugars, by C. L. HINTON, F.I.C., and T. MACARA, F.I.C.

The aldoses, *e.g.*, dextrose and lactose,

are quantitatively converted to the corresponding monobasic acids by iodine in alkaline solution at ordinary temperature, provided the proportions of alkali and iodine to sugar are suitably controlled. The slight oxidation of sucrose and levulose found by other observers is confirmed, and the extent of this action is shown to depend considerably on time and temperature of reaction as well as on the proportions of iodine and alkali used. Using standard conditions it is possible to determine sucrose accurately in mixtures by titration before and after inversion, but the determination of other sugars is liable to be affected by non-sugar reducing substances. The method is so convenient, however, that it recommends itself technically for approximate determinations of invert sugars.

CANADIAN ASBESTOS PRODUCTION.

According to the preliminary report on the mineral production of Canada, compiled by the Dominion Bureau of Statistics, the total asbestos mined during the first six months of 1923 amounted to 1,482,102 tons, of which 1,297,243 tons, or 87.5 per cent., was milled. Sales advanced to a total of 99,042 tons, valued at 3,574,762 dols., as compared with sales of 54,846 tons, valued at 1,894,232 dols. in the corresponding period of 1922.—*Board of Trade Journal, October* 4.

BRITISH INDUSTRIES FAIR.

In connection with notices recently published in certain daily papers, the Department of Overseas Trade states that the voluntary liquidation of the British Industries Fair (Birmingham) Incorporated, in no way affects the London British Industries Fair, organised by that Department. Nor will the liquidation of this Association and the transfer of the responsibility for the management of the British Industries Fair (Birmingham) to the Birmingham Chamber of Commerce prevent the holding of the 1924 British Industries Fair at London and Birmingham as usual. The London section will be open at the White City from April 28 to May 9, and the Birmingham section follows on May 12 to 23.

INTERVIEWS WITH H.M. SENIOR TRADE COMMISSIONER IN INDIA.

Mr. T. M. Ainscough, O.B.E., Senior Trade Commissioner in India, is at present in this country on an official visit, and will be in attendance at the Department of Overseas Trade during October for the purpose of interviewing manufacturers and merchants interested in trade with India. Such interviews will only be given by appointment, and all applications, quoting the reference 4814 T.G., should be addressed to the Comptroller-General, Department of Overseas Trade, 35, Old Queen Street, Westminster, S.W.1.

CAST IRON RESEARCH.

The Monthly Circular of the British Cast Iron Research Association contains valuable data on malleable iron, together with micros obtained from the research work in hand. This preliminary information should show the malleable industry how very essential it is to push forward a wide scheme of research. This early information will be supplemented in subsequent bulletins. Members only are privileged to obtain this information. Researches to discover a cast iron to resist corrosion are being carried out. Interesting data has been sent in by members, from which it is evident that the purposes for which cast iron was required to resist corrosion are fairly large.

THE EVOLUTION OF CHEMICAL TERMINOLOGY.*

By James F. Couch.

Comme ce sont les mots qui conservent les idées & qui les transmettent, il en résulte qu'il seroit impossible de perfectioner la science, si on n'en perfectionoit le langage.—Lavoisier.

The lack of ambiguity in the practical use of the term hydroxide may well occasion surprise that a consideration of this term has been included in this series of papers upon chemical terminology. There are few chemical terms more often used and certainly there is none which is used by

* [*Reprinted from "The American Journal of Pharmacy, Philadelphia, Pa., July,* 1923.]

the chemist with more specific meaning. It is one of the first items of information that he receives in his elementary course in chemistry. It stares at him from his little shelf of reagents in the laboratory, and it would not be exaggeration to say that the first example of applied chemistry he learns is the broad principle that hydroxides neutralise acids and may, therefore, remedy accidents to fabrics. His most indispensable reagents are sulphuric acid and sodium hydroxide, and he comes to know these substances as a painter knows brushes and a sculptor knows marbles. The chemist grows up in science with the concept hydroxide; it is always with him; it is ever in use; it finally becomes immanent in his very nature. Why, then, should he not be completely familiar with it? Where is there possibility of ambiguity or misconception in the use of this term?

From the foregoing it is easy to believe that I have never met the chemist who does not cherish a conviction that he knows what a hydroxide is. It requires more courage, however, to supplement that assertion with the statement that I have not yet met a chemist who really does know what a hydroxide is, and, furthermore, it is not at all difficult to convince any reasonable chemist that his knowledge in this respect is incomplete. If he doubts this a very few adroit questions will serve to bring him to an impasse and demonstrate the fact.

Some months ago I set out to investigate this term hydroxide. The examination of available facts led to the astonishing conclusion that there is no general agreement in the definition of the term, so that, strictly speaking, unless one specifically modifies the word when he uses it, he says next to nothing definitely when he employs the term hydroxide. In other words, we have here a most flagrant example of indefiniteness. Here is a concept which is in daily use, which enters into a large portion of all chemical thought, which underlies and conditions many important chemical theories; and it lacks the *sine qua non* of scientific terms, precise meaning!

This fact immediately becomes apparent *upon consultation of the dictionaries and* the textbooks of chemistry. We find a diversity of opinion among authorities *from* as is not always the case, they ven- by H. define the term. Many writers of Ordinary chemistries present no definition but content themselves with referring to the formation of basic hydroxide, but content themselves with referring to the formation of basic hydroxides through the interaction of water and alkaline oxides or by the reaction between sodium hydroxide and certain metallic salts. The various expressed views of the term hydroxide may be classified under four chief concepts: there is the view that these substances are compounds of water with oxides; fundamentally opposing this is the view that hydroxides are hydroxyl compounds and of this conception there are three main divisions: first, the idea that any hydroxyl compound is an hydroxide, second, the common notion which may briefly be stated thus, hydroxides are hydroxyl compounds of basic radicals, and third, a compromise between these extremes which allows the class hydroxide to embrace all hydroxyl compounds but prefers its application to basic substances.

The first view has few proponents to-day. It was, however, held by most of the early chemists and has been supported by very capable men. D'Aubuisson[1] in 1810 wrote:

"Mineralogists and chemists have too little fixed their attention on water considered as a constituent of minerals with the exception of those salts in which this substance has been remarked under the name water of crystallisation. Meanwhile the rocks of which it forms an essential constituent part are in great number; without mentioning those which compose the numerous family of the zeoliths I will cite the wavelite recognised by Davy and Klaproth as a true hydrate of alumina, composed of water and alumina in constant proportion. Diaspore . . . seems to be nothing but a hydrate of the same earth. The opal is probably only a hydrate of silica."

This quotation is interesting through the knowledge it gives us concerning conditions in chemistry a century ago. It appears that only a very few chemists had any real conception of the importance of water as a constituent in compounds and consequently it was too often overlooked. Berzelius,[2] however, grasped the significance of combined water, and in 1812 developed an hypothesis to explain it which influenced chemical thought for several decades. This was his notion of acid and basic water:

"Hydrate, oder Verbindungen des Wassers: Erstens: mit Säuren. In diesen spielt das Wasser ganz die Rolle einer Basis; die Säure nimmt davon zur Sätti-

gung eine Menge auf, welche genau so viel Sauerstoff als eine Salz-basis enthält, von der diese Mange Säure gesättigt wird.

"Zweitens: mit Salzbasen. Das Wasser spielt hier in so fern die Rolle eine Säure, als es ihre Stelle vertritt, enthält aber nur gleiche Theile Sauerstoff mit der Basis, oder ist zuweilen ein submultiplum vom Sauerstoff der Basis."

He uses the term hydrate freely, speaking of "Hydrate der Thonerde" and "Eisen Hydrate." Vauquelin[48] in 1813, repeating an analysis published by Prof. Bruce of New York, confirmed the findings of the American:

"It appears from this analysis that the mineral which formed the subject of it is simply a combination of magnesia and water (hydrate of magnesia)."

Vogel,[49] writing in 1818 "Sur les Hydrates," defined them thus:

"When water unites with a solid body and preserves with it the solid state, it is in this case, only, that one gives to the combination the name of hydrate."

He refers to soda and potash as hydrates, and mentions the hydrate of lead. None of these authors used the term hydroxide, for, at this time, it had not been generally accepted. Graham,[23] considering water as a constituent of salts, does not employ the term hydroxide, but he had the concept, for he distinguishes carefully between the water combined in acids and that in bases following the hypothesis of Berzelius already quoted. Thus Graham:

"In the hydrates of the caustic alkalies and of the earths, water is retained by a strong affinity, and is generally supposed to be united, like an acid, to the alkali or earth. In such hydrates water discharges an *acid* function."

"In the case of hydrates of the acids,* the portion of water which is found to be inseparable by heat, or to be very strongly retained, has generally been presumed to be in the place of a base to the acid, although little attention has been paid to the subject. The most highly concentrated sulphuric acid retains one atom of water, and is supposed to be a sulphate of water."

* *It is hardly necessary to remind the reader that at this era the oxy-acids were not regarded as hydrogen compounds, but what we now term the acid anhydrides, or acidic oxides, were termed acids and the combinations of these oxides with water were called hydrates of the acids.*

In the "Hand-Book of Chemistry" of Leopold Gmelin,[20] published in 1849, we begin to get a more definite statement about water-compounds; he defines oxides:

"The act of combination of oxygen with other bodies is called oxygenation (combustion); also acidification, when the resulting compound is of an acid nature; oxidation in the contrary case. The oxygen is the oxygenizing body (supporter of combustion); also, according to circumstances, the acidifying or the oxidizing body." v. 2, p. 38.

"Oxygen forms about 136 inorganic compounds; they are as follows:—

1. Of acid nature . . .
   a. Non-metallic oxygen acids . .
   b. Metallic oxygen acids . . .
2. Compounds not of acid nature: Oxides." v. 2, p. 38.

Gmelin does not use the term hydroxide, which, indeed, was not common in Germany, the word hydrate being there used. It is clear, however, that his idea of hydrates was that of the modern concept of basic hydroxides, and there can be no doubt that, had the question been raised, he would not have extended the term hydroxide to include the oxy-acids. Silliman[46] is not so definite:

". . . it combines with many substances, forming a large class of hydrates: hydrate of lime and potash are examples. It is also, as we have seen, essential to the acid properties of common sulphuric, phosphoric, and nitric acids, acting here the part of a much more energetic base than in the hydrates." p. 249.

He seems, nevertheless, inclined to limit hydrates to basic compounds. Newth[37] unequivocally asumes this position:

"Binary compounds that are formed by the union of elements with oxygen are called the oxides of these elements. Certain of these oxides are capable of entering into combination with water, giving rise to substances known as acids; such acids are distinguished as acid-forming oxides, or acidic oxides. They are also sometimes termed anhydrides. All the non-metallic elements, except hydrogen, form oxides of this order, and the acids derived from them are known as the oxy acids.

"Certain other oxides also unite with water, but give rise to compounds known as hydroxides. When such oxides, which are all derived from the metallic ele-

ments, are brought into contact with acids, chemical union takes place, and a compound termed a salt is formed. Such oxides are distinguished as salt-forming or basic oxides. There are also oxides *which are neither acidic nor basic."* p. 17.

These quotations serve to present a clear icture of the notion that hydroxides are *rater compounds and they show in addi*ion the diversity of opinion in respect to he limits of application of the term. It rill be obsereved that, while the term hyrate is used throughout in most of the citaions, the writers clearly had in mind those ompounds which to-day would be termed ydroxides. We turn then to the consideration of the view that hydroxides are hyroxyl compounds, and first examine the roadest application of this view.

This conception is not of very great age. t appears only a short time before the pubication of the theory of ionisation. 'ownes,[50] in 1885, and this is the earliest eference to this specific concept that I *ave found, says:*

"Water acts on many oxides, both acid and basic, with great energy and considerable evolution of heat, producing compounds called hydroxides." p. 159.

Under "hydrates," the 1889 edition of Vatt's "Dictionary of Chemistry," we ead the following:

"*Another way of stating the theoretical* difference between hydrates and hydroxides is to say that hydrates contain water as such, and that hydroxides contain the elements of water." p. 703, v. 2.

"The term hydroxide is sometimes used in a narrower sense than explained above; by some chemists it is applied *only to compounds whose reactions are* best explained by supposing them to contain the group or radicle OH." p. 704.

Remsen[42] in 1899 supported this view:

". . . the hydroxides form two of the most important classes of compounds, known as acids and bases." p. 61.

Goodchild and Tweney[21] define an hy*roxide thus:*

"A compound containing the hydroxyl group OH. Hydroxides may be acid or alkaline in character." p 298.

"*Funk and Wagnall's Dictionary*"[17] presents this definition:

"A compound containing the group hydroxyl, and formed by the union of the *molecules of water*, so that a rearrangement of the atoms takes place, yielding hydroxyl." p. 880

The "Handwörterbuch der Naturwissenschaften," Jena, 1914, is in accord with this view.

"Hydroxyde kennt man Verbindungen welche die einwertige 'Hydroxyl' gruppe *—OH enthalten.* . . ." *v. 5, p. 344.*

The definition given by "Webster's"[52] is:

"*A compound of an element or radical* with hydrogen and oxygen, not regarded as containing water. . . The term is usually applied, and by many chemists restricted, to compounds containing the group OH, or hydroxyl. Hydroxides may be basic, neutral, or acid, according to

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(To be Continued.)

NOTICES OF BOOKS.

The Chemistry Tangle Unravelled, by F. W. GRAY, M.A., D.Sc. Pp. VIII. + 148. London: Longmans, Green & Co., 39, Paternoster Row, E.C.4. 1923. Price 6s. net.

Before opening this little volume, the reviewer called to mind the vast mass of experimental work that had given rise to multitudes of inorganic, as well as organic, compounds. On the other hand, there are the countless theories dealing with comprehensive, limited, or even trivial sets of experimental facts and fancies.

Dr. Gray's book* is evidently an earnest endeavour of an ardent teacher to place before the student and drive home the essential fundamentals upon which the facts of Inorganic Chemistry are based.

At the present time there is urgent need for such a text-book, and in the main the author's attempt at unravelling the tangle has been successful. In doing so he has not hesitated to make use of the latest experimental results and theoretical deductions. He commences with the brief essentials of the historical development of the periodic classification of the elements, and including the subject matter and the latest information. Until recently, the periodicity of the elements was usually and most suitably represented by Mendeléef's Table. There are now other schemes (*e.g.*, Loring's Wedge Table, *The Chemical News*, 1922, CXXV., 387), and the author has incorporated a pyramidal scheme which he states is based on Langmuir's conceptions of atomic structure.

There are several minor points in which the reviewer feels that the volume might be improved to increase its general utility to students. It sometimes seems rather an account of the tangle than its unravelling. Thus, whilst avoiding a catalogue of facts, the author has gone to the extreme of assuming that the student already has a good general knowledge of them in his possession, even though they be in a tangle.

In the chapter entitled *Multiplex Anions and Multiplex Cations*, reference could be made to a number of bodies of very minor significance, and there is a tendency to coin expressions. Most of the information in the chapter on the Formation of Complex Ions is valuable and important, but the author is wrong in stating (p. 92) that magnesium chloride is the only chloride of group II. A which forms double chlorides. In the same chapter, the presence of water in certain double salts is disregarded.

Except at the end, there are no diagrams, which is a disadvantage, since these are very helpful in visualising various matters.

The author has undoubtedly produced a book which should stimulate a true interest in science in the students' mind, and those who take students through the labyrinths of advanced Inorganic Chemistry would probably profit by a perusal of this work.

J.G.F.D.

Alloys Resistant to Corrosion, a General Discussion held jointly by the Faraday Society and the Sheffield Section of the Institute of Metals, April 1923. Price 5s. 6d.

From time to time the Faraday Society arranges meetings for discussions on Physico-Chemical subjects of importance and interest. At these meetings papers are read and discussed by the eminent scientists who are invited and attracted.

Thus, in April last, there was a general discussion on Alloys Resistant to Corrosion, held jointly by the Faraday Society with the Sheffield section of the Institute of Metals, and the Manchester Metallurgical Society (an account of which appeared in *The Chemical News*, April 20, pp. 246-9). The contributions were subsequently published in the Society's Transactions, but in order to reach a wider public, are now reprinted in book form.

No definite theory of corrosion emanated from the discussion, but much valuable information was gathered together concerning the methods of prevention, etc.

The reprint is not only of interest to academic physicists and chemists, but also to engineers and technicians.

Chemistry, Inorganic and Organic, by Charles Loudon Bloxam. Eleventh edition, revised by Arthur G. Bloxam, F.I.C., and S. Judd Lewis, D.Sc., F.I.C. Pp. IX. + 832. London: J. & A. Churchill, 7, Great Marlborough Street. 1923. Price 36s.

In Bloxam's chemistry, both the Inorganic and the Organic Sections of the science are considered in adequate detail and in one volume. This arrangement certainly has obvious advantages, especially from the point of view of the student who needs a general knowledge of the whole science. It is evident that the present authors had this in mind, since there is a long section on the general principles of Physical Chemistry which has been inserted following the treatment of the non-metals and preceding the chemistry of the metals.

The early chapters deal with water and its elements; the Air and its constituents and the general properties of Gases; hydrogen, occlusion, reduction, oxidation; the halogens; the sulphur, phosphorus, carbon and boron, and argon groups.

The treatment of the metals as based upon the Periodic Classification.

The chapters on organic chemistry follow the usual plan of arrangement, except that

aliphatic and aromatic substances are described together in the same chapter.

By incorporating both branches of the subject in one volume, the authors have been able to describe such organic metallic derivatives as the cyanides, simple and complex, in a chapter in the organic portion of the book. They have, however, given an account of acetylene, ethylene and methane in the inorganic section.

The section on physical chemistry gives a good account of the present position in that subject and, as might be expected, the chapter on spectroscopy is particularly good.

Whilst such a comprehensive volume as this lends itself to criticism on the grounds that some sections must receive better treatment than others, it must be admitted that this edition fully maintains the traditions of the previous ones.

BOOKS RECEIVED.

From Determinant to Tensor, by W. F. SHEPPARD, Sc.D., L.L.M. Pp. VIII. + 27. 1923. The Clarendon Press, Amen Corner, Paternoster Row, E.C.4. 8s. 6d. net.

Radio-Activity, by K. FAJANS, Professor of Physical Chemistry in the University of Munich. Pp. XII. + 138. 1923. Messrs. Methuen & Co., Ltd., 36, Essex Street, W.C.2. 8s. 6d. net.

Kolloide in der Technik, von DR. RAPHAEL ED. LIESEGANG. Pp. 157. 1923. Herr Theodor Steinkopff, Residenzstrasse 12b, Dresden & Leipzig.

We have received a copy of the *Year Book of the Michigan College of Mines*, 1922-23, which also contains announcements of the courses of instruction for the session 1923-24.

We have received a copy of the Prospectus of University courses in the Municipal College of Technology. It gives particulars concerning the College and its courses and examinations.

PAMPHLETS ISSUED BY THE UNION OF SOUTH AFRICA, DEPARTMENT OF AGRICULTURE.

Notes on the Chemical Control of Cattle-dipping Tanks, by C. O. WILLIAMS, B.Sc. Pp. 137 + 141.

The Estimation of Fineness in Basic Slag, by DR. CHAS. F. JURITZ. Pp. 5.

Some Analytical Methods, by H. F. L. [illegible]

Some Observations on the Sulphate-Molydate Method of Determining Phosphoric Oxide, by V. A. BECKLEY and A. MARAIS. Pp. 5.

Investigation of Different Methods of Testing Babcock Milk Bottles, by C. O. WILLIAMS, B.Sc., A.R.C.S. Pp. 132 + 136.

Representative Transvaal Soils. The High Veld Sandy Soil, by B. DE C. MARCHANT, B.A., D.Sc. Pp. 6.

The Composition of Some Indigenous Grasses, by ALEXANDER J. TAYLOR, B.A. Pp. 218 + 232.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5. Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

23557—Casale, L.—Production of catalysts for synthesis of ammonia. Sept. 20.

23570—Casale, L.—Apparatus for catalytic production of synthetic ammonia. Sept. 20.

23424—Dreyfus, H.—Manufacture of aliphatic compounds. Sept. 10.

23565—Fraymouth, W. A.—Recovery of calcium oxalate, &c., from trees. Sept. 20.

23231—Badische Anilin & Soda-Fabrik.—Manufacture of active carbon. Sept. 17.

23348—Badische Anilin & Soda-Fabrik.—Production of vat colouring-matters. Sept. 18.

203533—Badische Anilin and Soda-Fabrik—Manufacture and production of dyestuffs and intermediate products therefor.

203551—Hovey, R. B., and Hovel, F. L.—Nitrate of lime.

Specifications Published this Week.

203352—Weizmann, C., and Blumenfeld, J.—Production of titanic acid.

203383—Perkins, W. G., and Beasley, W. H.—Production of refined copper from copper oxide.

186329—Parodi, P. Distilling apparatus for continuous operation.

Abstract Published this Week.

201786—Dyes.—Kalle & Co., Akt Ges., 23, Rheinstrasse, Biebrich-on-Rhine, Germany.

Perylene derivatives.—By treating perylene-3:4:9:10-tetracarboxylic acid, or a substitution product thereof, with ammonia or primary aromatic or aliphatic amines, it is converted into difficultly soluble imides which dye animal and vegetable fibre in fast red to blue-violet shades from the vat. In examples the acid or its ammonium salt is heated with ammonium carbonate, methylamine hydrochloride, or aniline; other suitable amines are *p*-chloraniline, α- or β-naphthylamine, α- or β-amino-anthraquinone, also diamines such as *o*-, *m*-, and *p*-phenylene-diamines, 1:8-naphthylenediamine, and benzidine. The perylene 3:4:9:10-tetracarboxylic acid may be prepared by oxidizing with hypochlorite, chromic acid or other oxidizing agent, the vat dyes made by alkali fusion of perinaphthindanone or perinaphthindandione.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only

THE CHEMICAL NEWS,

VOL. CXXVII. No. 3314.

AN EXPLANATION OF THE THEORY OF THE ROTATION OF THE ATOMIC NUCLEUS.

Part IV.

By Herbert Henstock.

Oxides (*continued*).

Group V.

Before discussing the oxides of this group and especially those of nitrogen, it will be necessary to examine the very interesting case of the nitrogen molecule itself. Presumably the two nitrogen atoms are linked by a treble bond, and in that case both atoms will have distorted octets, which would most probably take the forms described below.

If we take the positive nitrogen atom and distort it, as shown in Fig. 1 A, the dotted lines indicating the parts of the cube which will vanish, we should then have a figure as shown in Fig. 1 B.

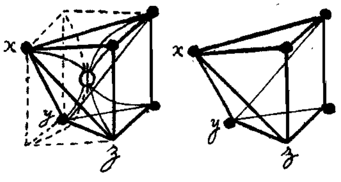


Fig. 1

If the whole of Fig. 1 B. be now turned through an angle of 90° so that the side x y of the triangle x y z comes uppermost, it will be seen as in Fig. 2 A. In order to form a treble bond the negative atom would be as shown in Fig. 2 B., and if this were taken up, turned over, and applied to the positive atom so that x y and z in each atom coincided, then the bond would be complete and the molecule of nitrogen would be formed.

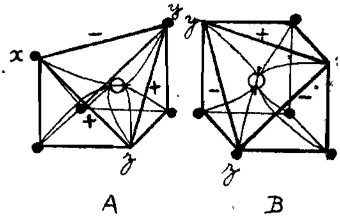


Fig 2

On viewing this arrangement, several interesting points will be noticed.

(1) The two atoms exhibit no free valencies.

(2) Both cubes are distorted to the utmost, which the number of electrons will permit, in a similar way to carbon as represented by the tetrahedron.

(3) No cube face is opened up in either atom in order to form the bond, such as occurs in the case of carbon-monoxide. Therefore the nitrogen molecule will be very stable, since a partial opening up encourages further opening up, so that the nitrogen molecule should be more stable than that of CO, which is, of course, the case.

(4) The positive atom, if viewed as in Fig. 1 B., is seen to be identical in shape with that which the carbon atom has in carbon-monoxide. (See Part III., *The Chemical News*, 1923, CXXVII., 18.)

(5) There are the same number of electrons in the combined octets of the nitrogen molecule as in those of CO.

In a paper by Bone, Hewitt and Townsend, read before the Royal Society (April 27, 1923), Professor Bone stated that, "In the combustion of mixtures of $2CO + O_2$ with nitrogen as a diluent, the nitrogen exerts a peculiar energy absorbing influence, far beyond that of other di atomic diluents, and also that this energy absorbed is slowly liberated again as the system cools down." This absorption of energy may be due to the opening up of the octet of the positive nitrogen atom, which might go as far as the rupture of the treble bond with formation of a single bond or even the complete separation of the atoms, which would permit of the opening up of the full octets of both atoms, and thus leave them with three free and active valencies apiece, permitting their

union with other atoms such as oxygen. The same thing probably occurs when a high tension electric current is passed through air; in this case, considerable energy is required to produce this effect, and it is therefore more than probable that both these absorptions of energy are due to the same cause. The converse of this opening up process would occur on cooling, with consequent re-emission of energy. This also agrees with their further statement that "The nitrogen becomes activated and will combine with oxygen when in this state"; the activated condition is that in which the octets are reformed ready for union with other atoms, in fact the converse of the process shown in Fig. 1.

Again, they state that "If nitrogen is used as a diluent in exploding mixtures of hydrogen and oxygen, no such activation occurs, and that a small percentage of hydrogen introduced into a carbon monoxide-air mixture is sufficient to prevent it." They deduce from this that "The peculiar influence of nitrogen in $2CO + O_2$ explosions is due to its ability to absorb the particular quality of radiation emitted when CO and oxygen (but not when CO, oxygen and hydrogen) react; such radiation is known to be of a different wave length from that emitted during the flame combustion of hydrogen. In other words, there seems to be some constitutional correspondence between CO and N_2 molecules whereby the vibrational energy emitted when the one reacts with oxygen is of a quality readily absorbed by the other, the two acting in resonance." Now, if observation No. 4 (see above) be considered in connexion with this, it seems highly probable that the exact similarity in configuration of the carbon and positive nitrogen atoms in the two gases, combined with the fact that each molecule contains the same number of external as well as internal electrons (observation 5), may account for the two vibrating concurrently, *i.e.*, the similarity in structure accounts for the similarity in resonance effects. The hydrogen molecule, having an entirely different configuration from that of CO or nitrogen, would inhibit such concurrent vibration.

Referring to their statement that "This energy absorbing effect in nitrogen is far beyond that of all other di-atomic gases"; the structures be worked out on the lines given above, no other di-atomic gas, with the possible exception of cyanogen, will be found to have a configuration anything like that of either CO or nitrogen; and even cyanogen, the nearest to them, has 9 electrons in the combined octets of its molecule, whereas CO and nitrogen have 10 each.

This arrangement of the nitrogen molecule is the nearest approach to a sphere which can be obtained with the octets of the two atoms, which agrees with the calculations of Rankine (*Proc. Roy. Soc.*, 1921, A. 98, 360, 369, 331) of the atomic and molecular diameters, obtained from the viscosities.

The oxides of nitrogen will be represented as follows:—Nitrous oxide, $N \equiv N = O$ in Fig. 3.

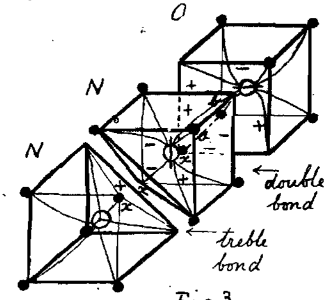
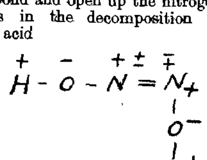


Fig 3.

This formula gives a better explanation than any other of the ready formation of the nitrogen molecule when oxygen is abstracted from N_2O; all that will happen after the oxygen has left the molecule is that the electron from (*a*) will travel to (*b*), and the cube corner at (*a*) will vanish, leaving a triangle and thus reforming the nitrogen molecule.

A further argument in its favour is that N_2O, which might be looked upon as the anhydride of hyponitrous acid, does not unite with water to form that acid, since water is not a strong enough reagent to rupture the treble bond and open up the nitrogen octets, whereas in the decomposition of hyponitrous acid



o N_2O and water, the treble bond might be asily reformed from the double bond.

It is also in agreement with Rankine's alculations (*loc. cit.*), in which he finds hat CO_2 and N_2O molecules are similar in ize and shape, which can be seen by comparing this formula with that given for CO_2 n Part III. It will also be noticed that he two gases have the same number of exernal electrons in their molecules.

It presents no free valencies in the nitrogen atoms which precludes the easy addiion of oxygen to form higher oxides. As hus constituted, there are two weaknesses n the N_2O molecule.

(1) In the pentavalent nitrogen atom, oth positive and negative bonds come into lay (rule 2).

(2) The corner at x (fig. 3), which is hared by all three atoms, will be occupied y two electrons (rule 6).

The oxygen atom is, for these reasons, asily detached from the rest of the moleule.

Nitric oxide N=O in Fig. 4.

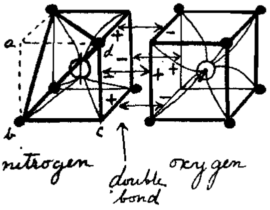


Fig. 4

(*To be continued.*)

SOME RECENT RESEARCHES IN ORGANIC CHEMISTRY.

By R. F. Hunter, F.C.S.

Researches in the field of Organic Chemistry, have increased during the last few years in such number and magnitude that a mention of a few of the problems, and it can be little more than a mention which our leading researchers and pupils have been attacking, would not seem out of place. Since those of us who are academic researchers and whose duty it is, therefore, to keep pace with the enormous work which is being done, are finding it increasingly difficult to keep pace with new developments, we fear that the industrial chemists amongst us must, in the main, have given up (save where their own specialised branches are touched on) as a hopeless task the attempt to keep pace with the researches carried out in the laboratories of our Universities. This being so, a series of articles on the subject should not be out of place. One point necessary to mention is this—the brilliant work which has been carried out in the laboratories of the Royal College of Science during the last ten years or so under the guidance of Prof. J. F. Thorpe and Dr. C. K. Ingold on Dynamic Tautomerism, Stability of Spiro Compounds, etc., has not been included, for the reason that it will be dealt with much more fully at a later date. The researches with which we propose to deal are those which have taken place during the last three years or so, that is to say, we do not propose to go further back than 1920, and further to confine attention on the work done in this country.

The greatest difficulty is obviously to separate the most vital considerations from the hosts of other important considerations, and in the present state of knowledge and the extreme recent date of the work this becomes difficult. This being so, it will not be thought necessary if less important problems, since they will only be shown to he of lesser importance at a later date, are given more consideration than more vital problems. In composing this piece of work, the material has, largely, been based upon the accounts given in the Chemical Society's *Journal*, where full experimental details and foreign references can be found.

An interesting preparation, that of chlorpicrin from picric acid and tri nitro toluenes, was investigated by Orton and McKie. They prepared chlorpicrin by dissolving picric acid in sodium carbonate to give the sodium salt, obtained a paste, and acted on this with chlorine at 5° C. They examined the solubility of chlorpicrin in water, and also investigated the action of a hypochlorite solution on

o & p Nitro phenol,
2:4 Dinitrophenol,
and Trinitro toluene and tri nitro toluene residues.

The research was communicated to the Chemical Society in November, 1920.

The same month, Chattaway and Ray

studied the old familiar problem of the decomposition of tartaric acid by heat.

Tri thio carbonate and per-thiocarbonates were investigated by Yeoman at this time. Among the problems studied were the method of analysis, the compound sodium tri thio carbonate and the corresponding potassium, calcium, barium, strontium and ammonium salts. About this time the first part of Henstock's work on the bromine compounds of phenanthrene appeared. Briefly we can say that he prepared compounds which appear to be, and which he headed as

2 (?) Bromophenanthrene Dibromide,
2 (?) 10 Dibromophenanthrone,
2 (?) 10 Dibromophenanthrone,
2 (?) 10 Dibrom 9 nitro phenanthrone,
2 (?) 10 Dibromo 9 amino phenanthrone,
10 Bromo 2 ethoxy phenanthrone, and
9:10 Dinitro 2 ethoxy phenanthrone.

In the next month, McKenzie and Barrow published a paper on β amino, β phenylpropio phenone, this being the result of the fact that for another research it was desired to obtain a β amino ketone containing an asymmetric carbon atom.

In the experimental work, we have the preparation of β amino β phenyl propionic acid from cinnamic acid and hydroxylamine and the study of the action of β formylamino β phenyl propionyl chloride on benzene in the presence of aluminium chloride, the action of cinnamoyl chloride on benzene under the same conditions. Also the preparations of

β Benzoylamino β phenyl propiophenone,
β Phthalimino β phenylpropionic acid,
β Phthalimino β phenyl propiophenone,
β Benzoyl and phenyl ethyl phthalamic acid, and
β Amino β phenyl propiophenone.

About this time a communication of Coffey's appeared on the action of sulphur chlorides on substituted ethylenes, the action of propylene on sulphur monochloride and the synthethis of $\beta\beta'$ "Dichloride n propyl sulphide, one of the many researches entailed by the production of mustard gas $\beta\beta'$ "dichlorethyl sulphide for war purposes. It was considered that propylene would react similarly to ethylene,

$$2C_2H_4 + S_2Cl_2 = (Ch_2\ Cl\ CH_2)_2\ S + S.$$

A small quantity of $\beta\beta''$ 'dichloridi n propyl disulphide was isolated.

$\beta\beta''$ 'dichloride di n propyl sulphide was prepared according to the scheme

$CH_3\ CH\ (OH)\ CH_2Cl$

$(CH\ CH\ (OH)\ CH_2)_2\ S$

The oxidation of $\beta\beta'$ dichlorodi n propyl sulphide by nitric acid was also investigated.

Brady and Gibson communicated from Woolwich Arsenal the results of a research upon

2 : 4 : 6 Tri nitro totyl methyl nitroamine.

The preparation of a number of related compounds were incidentally discussed.

Arylazoglyoxaline carboxylic acids were studied by Fargher about this time, the work mainly experimental, and among the preparations were 4-p-Bromobenzeneazo 2-phenyl glyoxaline-5-carboxylic acid 4-p-Bromobenzeneazo 2-methylglyoxaline-5-carboxylic acid 2-p-Bromobenzeneazoglyoxaline 4 : 5-dicarboxylic acid.

Meanwhile Nierenstein published the third part of the research on the constitution of catechin and the synthesis of acacatechin. The communication contained the synthesis of 2 : 4 : 6 : 3' : 4'-pentahydroxy-3-phenylchroman. This was obtained by the following method:—3 : 4 : 2' : 4' : 6'-penta-methoxy-diphenylmethylchloromethyl ketone was converted into 4 : 6 : 3' : 4' tetramethoxy-3-phenylchroman-2-one, this reduced to 2-hydroxy-4 : 6 : 3' : 4'-tetra-methoxy-3-phenylchroman, and this, on demethylation, gave the required 2:4:6:3':4'-penta-hydroxy-3-phenylchroman.

Morgan and Vining studied in some detai the subject of Dihydroxy naphthaldehydes. Among the general preparations were those of Dihydroxy naphthaldehydes and their p Bromo phenylhydrazones, $C_6H_4Br\ NHN : CH\ C_{10}\ H_5\ (OH)_2$, Dihydroxy naphthylideneanilines, $C_6H_5N : CH\ C_{10}H_5\ (OH)_2$.

A paper of Morgan and Jones appeared on ortho Chlorodinitro toluenes, and among the questions studied were:

Nitration of 2 Chloro 6 nitro toluene;
Action of diazonium salts on 6 Chloro; 2 : 4 tolylenediamines.
The action of primary amines on 4 : 5 and 5 : 6 dinitro o chlorotoluenes.

In January, 1921, a number of papers on organic research were communicated to the J.C.S., these were briefly as follows:—

The constitution of Disacharides, Pt. V. Cellobiose, by Haworth & Hirst, which consisted essentially of the preparation of cellobiose, octa acetate, the methylation of cellobiose, isolation of heptamethyl methyl cellobiose, the hydrolysis of heptamethyl methyl cellobiose, and the conversion of crystalline tri methyl glucose into tetra methyl glucose.

Meldrum, appeared, in which condensations of gallic acid were examined. In the experimental work there appeared

3 : 4 : 5-Tri-hydroxy-2-tri-chloromethyl phthalide.

The lactone of 7 : 8 dihydroxy 2 : 4 bis tri-chloro-methyl-6-β-trichloro - a-hydroxy-ethyl 1 : 3-benzdioxine-5-carboxylic acid.

The lactone of 7 : 8 βββ-trichloroethylidene dioxy 2 : 4 bis tri chloro methyl 6 βββ-tri-chloro a hydroxyethyl-1 : 3-benzdioxine-5-carboxylic acid. 6-Methyl-2 : 4-bis-tri-chloromethyl-1 : 3-benzdioxine - 8 - carboxylic acid. 4 Hydroxy 5 ββ dichlormethyl-m-toluic acid. 6 Hydroxy 5 carboxy-m-tolylacetic acid, and βββ-trichloro 4 : 4′ dihydroxy a a di-m-tolyethane-5 : 5′-dicarboxylic acid.

A short paper by Singh and Lai appeared on substituted Quaternary Azonium compounds, which contain an asymmetric carbon atom.

The work of Barrow and Griffiths on the condensation of p-nitro-benzyl-chloride with nitroso compounds, which contained a new mode of formation of N Oximino ethers, appeared, the experimental part of which contained the study of p-nitro-benzaldoxime-N-phenyl-ether.

$$NO_2 . C_6H_4 . CH : N . C_6H_5 : O.$$

Perkins and Tucker's research on the oxidation of carbazole appeared about this time. In the experimental portion, we have the oxidation of carbazole by permanganate of potash in acetone solution. From the reaction two isomeric dicarbazyls were isolated, both of formula $C_{24}H_{16}N_2$, a third amorphous product of oxidation was isolated. All three substances were found to be capable of nitration, bromination, and to react under certain conditions with acetic anhydride.

Towards the end of December, 1920, Hepworth communicated an investigation on the action of Grignard reagent on nitro esters.

The scheme of reactions was of the form

$$R.ONO_2 \rightarrow RO. N R_2^1 (OHg X)_2 \rightarrow R O N R_2^1 (O Hg_x) Hg X \rightarrow RO NH (OH) R_2^1$$
$$R O H + NR' R' OH.$$

Among the preparations were:

Dimethyl hydroxylamine hydrochloride and oxalate, and the reactions studied were those of

Mg MeI on ethyl nitrate, Mg Et Br on ethyl nitrate, Mg Br Et on ethylene glycol dinitrate. Mg MeI and Mg Br Et on nitroglycerin and pentaerythritol tetranitrate.

Crossley and Renvuf contributed a paper on 1 : 1 dimethyl cyclohexane from heptenone, the research was mainly on Kelinsky's previous work. At the same time there appeared another paper by Nierenstein on Gallotannin. The work was mainly quantitative, and essentially consisted of quantitative observations on production of Ellagic acid from gallotannin and several gallotannin residues were studied.

(*To be continued.*)

THE BRITISH EMPIRE EXHIBITION (1924).

The Editors of the various technical journals met Mr. Woolcock, the General Manager of the Association of British Chemical Manufacturers, at the offices of the Association in Piccadilly, to discuss with him the progress which has been made with the preparation of the Chemical Section. In the course of the conversation Mr. Woolcock said:—

"The Chemical Section which is being organised by the Association, and occupies nearly 40,000 square feet in the Palace of Industry, will be built in such a way as to form a hall within the palace. About one hundred thousand pounds will be spent in presenting to the public a picture of the present state of British Chemical Industry. No important firm in the industry will be unrepresented, and the whole of the individual exhibits, numbering about one hundred, will, by reason of their position and character, combine to form a magnificent illustration of the industry. The treatment of the individual stands is being done on lines which have never before been attempted, and the old and somewhat hideous structures which have disfigured exhibitions in the past will not appear. Considerable attention has been paid to the lay-out and to the decoration of the Chemical Hall. There will, for example, be about two hundred yards of a specially painted frieze, illustrating various operations in chemical manufacture, and as the majority of the stands are being designed by the same architect, the treatment of each stand is likely while maintaining the individuality of the occupier, to present a very pleasing picture of the hall as a whole. It has not, however, been considered sufficient that we should merely show visitors examples of the products of the industry. The best possible exhibition of this kind would leave one question unanswered. The visitor may be satisfied that he is witnessing a demonstra-

tion of the position to which the industry has attained, but what the critical person who examines the exhibit requires to know is whether there is behind this example of what has been achieved a scientific basis which will ensure the continuance of this progress. For this reason, in the centre of the Chemical Hall, there is to be illustrated the progress which has been made in pure chemistry during the past twenty or thirty years, with a view to showing that the stream of scientific invention in this country is still flowing steadily onwards."

Mr. Woolcock then proceeded to outline the scheme of classification which has been adopted for the Scientific Section, and enumerated a number of names of those scientists who have already promised their assistance, and very few of the outstanding scientific men of the day were absent from the list. Continuing, Mr. Woolcock said: "The Scientific Section is being organised by a Committee consisting of representatives of the following bodies:—

The Chemical Society.
The Institute of Chemistry.
The Society of Chemical Industry.
The Society of Dyers & Colourists.
The Pharmaceutical Society.
The Institution of Petroleum Technologists.
The Institution of Chemical Engineers.

The Committee is working in close co-operation with the Royal Society. Sir Herbert Jackson acts as the representative of the Royal Society on the Committee, and myself in a similar capacity on the Royal Society Committee. In this way we shall prevent any overlapping. In order that both the general public and scientific persons may have a record of the exhibit, it is proposed to publish a number of pamphlets (specially written for the purpose) dealing in popular language with the various classes of exhibits in the Scientific Section. In addition to this it is proposed to publish in more technical language a work, which will not only explain the scientific exhibits, but which will put on record in a very complete form the state of our knowledge in chemical matters at the date of the Exhibition. It is anticipated that there will be a very large demand for this valuable record, and that it is likely to find a place on the bookshelf of every scientist. The various chapters will be written by the acknowledged experts in their subjects, and I anticipate that the contents of this book will be very valuable matter for reference."

Mr. Woolcock invited the assistance of the Editors in making widely known wha being prepared for the Exhibition nex year, and, the following resolution wa unanimously passed:—

"That our best thanks be extended t Mr. Woolcock for his courtesy in invitin the Editors of the trade and technica press to meet him, and that we under take to give him any assistance in ou power in organising the publicity servic of the Chemistry Section."

ANHYDROUS ALUMINUM CHLORIDE.

[Abstracted from Technical Paper 321 By OLIVER C. RALSTON, issued by th U.S. Dept. of the Interior, Bureau o Mines.]

Anhydrous aluminum chloride is a pur white microcrystalline solid which is usuall yellow to brown, or bluish to greenish, du to the presence of impurities, especiall iron. When heated, it sublimes with onl a hint of fusion and the temperature of sub limation—between 181° and 195° C.—i somewhat difficult to measure. Under a pressure of about 2.5 atmospheres, it can b melted at 194° C. Its boiling point at at mospheric pressure is thought to be abou 179° C. When condensed, the ruling tem perature in the condenser is about 181° C.

Aluminum chloride is extremely hygroscopic, absorbing moisture from the air to form aluminium oxide (Al_2O_3) and hydrogen cholride (HCl); the smell of the latter is always noticeable whenever a container of aluminium chloride is opened. This reaction between moisture and aluminum chloride often does not take place at once, but the hydrochloric acid is given off slowly on standing. If the surface of a mass of anhydrous aluminum chloride is allowed to "glaze" with a coating of aluminum chloride hydrate ($AlCl_3.6H_2O$) and the mass is then sealed in a tight container, the water of the hydrate solwly diffuses to the remaining anhydrous material and reacts to form aluminum oxide and hydrochloric acid gas. As the reaction proceeds the pressure of the gas finally becomes strong enough to burst the container. A glass bottle filled with aluminum chloride which has been exposed to the open air for a few minutes before being placed in the bottle may blow its stopper in this way. Large drums filled with the commercial product have been

known to "explode," probably from this cause.

This chloride is compeltely soluble in a large excess of water, with no visible hydrolysis; it dissolves with a hiss and with the generation of heat. Aluminum chloride is also easily soluble in alcohol, ether, and liquid chlorine, and dissolevs quickly in dry petroleum products, producing a brown to black colouration. Sample bottles containing anhydrous aluminum chloride should not be sealed with paraffin, as the salt will turn it black. The solution of aluminum chloride in a petroleum product may segregate into two layers on standing, with the aluminum chloride dissolved in the highly coloured lower layer. On heating, this layer mixes with the one above. No tests have been made to see if a small amount of aluminum chloride is also contained in the upper layer. Aluminum chloride is much more soluble in warm than in cold oils; in fact, at the petroelum refineries it is dissolved in warm oil and piped to the stills, where it is used as a catalyzer.

In the fused condition anhydrous aluminum chloride mixes with sodium chloride in all proportions. The double compound, $AlCl_3$-NaCl, is supposed to exist and to have a melting point of 185° C. It has been obtained by volatilising a mixture of salt, alumina, and carbon by treatment with chlorine. The writer has not made a quantitative study of the system NaCl-$AlCl_3$, but has prepared mixtures of the two which were completely fluid at a temperature as low as 136° C. A eutectic between the double compound and aluminum chloride probably melts at about this temperature. The double compound formed the basis of the early aluminum industry; it was the bath from which aluminum was deposited by metallic sodium, until the present cryolite-alumina electrolytic bath displaced it.

The first large-scale use of aluminum chloride was in the preparation of aluminum metal by the reaction of sodium metal on the fused double aluminum-sodium chloride. At first, pure anhydrous aluminum chloride was made and added to the bath as the latter became depleted in aluminum; later, it was found much more conevnient to prepare the double compound, which was more stable in air, not so hygroscopic, and could be melted and cast into blocks or rods ready to drop into the bath.

Anhydrous aluminum chloride is also used on a large scale in carrying out Friedel-Crafts organic reactions. The aluminum chloride acts as a catalyst, causing the combination of two materials that would otherwise be indifferent to each other. In the manufacture of many dyes, perfumes, drugs, and pharmaceuticals a catalyzer is used at some point in the process. Aluminum chloride is classed more or less with zinc chloride as a "condensing agent" for organic chemical work.

Aluminum chloride is also being considered for the bleaching of brick, as red brick can be bleached to buff if iron is replaced by aluminum. Some steel companies have claimed, moreover, that the chloride could be used in removing certain impurities from molten metal. Any of the uses mentioned might develop on a larger scael if a cheap product could be produced.

The refining of petroleum, however, uses the largest amount of aluminum chloride at present, and seems likely to demand additional supplies of the chloride in the future. This salt seems to fulfil several major functions in the treatment of petroleum products.

First, it converts all unsaturated compounds. Frequently this conversion is made by throwing out the excess of carbon over hydrogen in the hydrocarbon, whereupon the carbon blackens the aluminum chloride and forms a coke; gases need not be liberated. The most astonishing consequence of this saturating action is that unstable gasoline and lubricating oils made from asphalt-base petroleum yield excellent stable products of good colour and odour; in fact, they are almost paraffin-base products.

The second main effect obtained by boiling petroleum products in the presence of aluminum chloride is a cracking action. High-boiling hydrocarbons can be converted into low-boiling hydrocarbons, with the formation of some coke and some fixed gases as by-products. A topped oil, a gas oil, or a fuel oil can be treated with aluminum chloride catalyzer in a simple boiling still at atmospheric pressure with a yield of 60 to 85 per cent. of low-boiling oil containing fractions of petroleum ether, gasoline, and kerosene. The residue is coke containing the aluminum chloride, and can be used over several times before it becomes exhausted by the aluminum chloride losing its activity. Possibly the aluminum chloride is buried in the carbon or combines with it. The distillates are all saturated sweet-smelling products.

If desired, the distillation need not be

carried compeltely to coke, but can be stopped, and some excellent lubricants will be found in the heavier fractions remaining. Because of the volatility of aluminum chloride, a reflux must be used to catch its vapours and return them to the still with any condensed hydrocarbons. This means that nothing heavier than kerosene can get past the reflux. If desired, the reflux can hav its temperature so adjusted that nothing but gasoline and lower boiling hydrocarbons can get past it into the condenser. If the boiling is continued, everything in the still is cracked into gasoline, gas, and coke. The amount of coke remaining in the still is a fraction of the percentage of carbon originally present in the raw hydrocarbons treated.

A third function of aluminum chloride in petroleum refining is to remove sulphur from the oil. Part of the sulphur is converted into hydrogen sulphide gas and possibly aluminum sulphide is formed. At any rate, aluminum chloride is a very efficient desulphurizer. The desulphurizing uses up aluminum chloride, and for high-sulphur oils a correspondingly larger amount of aluminum chloride is needed. Consequently, to make the process commercialy feasible, only a very cheap product can be used for removing sulphur, and enough of an excess must be added so that there will be free aluminum chloride to act as catalyzer for the saturating and cracking.

METHODS OF PRODUCING ANHYDROUS ALUMINUM CHLORIDE.

Oersted, who first prepared aluminum chloride, passed a current of dry chlorine over a heated mixture of carbon and alumina. This method was afterwards used by Wöhler (1827), Leibig (1830), Bunsen (1854), and Deville (1849). Deville was one of the fathers of commercia laluminum metal, and used aluminum chloride as the raw material from which to extract it. The following methods of producing aluminum chloride are not grouped chronologically, but rather by relative importance in present manufacture. Those near the end of the list are largely processes collated from patent literature or elsewhere.

1. Dry chlorine gas acting on aluminum metal.
2. Dry hydrochloric acid gas acting on aluminum metal.
3. Chlorine gas acting on mixtures of aluminiferous and carbonaceous materials.
4. Chlorine gas or hydrogen chloride acting on aluminum carbide.
5. Chlorine gas acting on aluminum nitride.
6. Chlorine gas and carbon disulphide vapour acting on aluminiferous materials.
7. Chlorine compounds of carbon acting on aluminierous materials.
8. Chlorine compounds of sulphur or arsenic acting on aluminiferous materials.
9. Dry lead chloride reacting with aluminum metal or with aluminum carbide.
10. Anhydrous calcium chloride reacting with aluminiferous materials.
11. Aluminum chloride solutions prepared by any wet method, then evaporated and the crystals dehydrated.

All of these methods, with the exception of method 11, are performed at high temperatures, usually high enough to sublime any aluminum chloride formed. In fact, the great volatility of aluminum chloride is frequently the main inducement to reaction and many of the above processes are endothermic. Details of each of these groups of methods are discussed on the following pages.

THE EVOLUTION OF CHEMICAL TERMINOLOGY.*

By JAMES F. COUCH.

(Continued from Page 238.)

"A compound of an element or radical with hydrogen and oxygen, not regarded as containing water. . . The term is usually applied, and by many chemists restricted, to compounds containing the group OH, or hydroxyl. Hydroxides may be basic, neutral, or acid, according to the nature of the combining atom or radical. Most hydroxides, commonly so called, however, are basic." p. 1055.

On April 20 of this year *Science** published a list of rules adopted by the Nomenclature Committee of the American Chemical Society and that of the London Chemical Society, in which the following appears:

"The word *hydroxide* should be used for a compound with OH and *hydrate* for a compound with H_2O. Thus, barium hydroxide, Ba $(OH)_2$; chlorine hydrate, Cl_2 10 H_2O."

Murray[36] defines hydroxide as:

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* *Science*, N.S. 57, 474 (1923).

* [*Reprinted from "The American Journal of Pharmacy, Philadelphia, Pa., July, 1923.*]

"A compound of an element or radical with oxygen and hydrogen, not with water; by some chemists restricted to compounds whose reactions indicate the presence of the group hydroxyl (OH)." p. 491, v. 5.

Mellor[32 33] extends the term to all hydroxyl compounds but recognises that it is used in the narrower sense where it applies only to basic compounds. In this modified view he is in accord with Silliman.[46] He says:[32]

"From this point of view water can be regarded as hydrogen hydroxide, H-OH, analogous with K-OH, potassium hydroxide, and Na-OH, sodium hydroxide. Excluding certain carbon compounds, the hydroxides of the non-metallic elements are usually acids, and the hydroxides of the metals are usually bases. The term 'hydroxide' is generally reserved for compounds of the basic oxides with water; and the term 'anhydride' is usually reserved for the acid anhydrides." p. 146.

The same idea is repeated in his great "Comprehensive Treatise,"[33] and here he insists upon the broadest extension of the term in theory:

"Every element, excepting fluorine and the argon family, appears to form one or more hydroxides, directly or indirectly." v. 1, p. 395.

Sharply contrasted with these views is that concept of the term hydroxide which to-day is held by the great majority of chemists, the limitation of the term to those hydroxyl compounds which exhibit basic properties. As I shall show, this view is the original idea expressed by the term, and has heen held continuously, although obscured and distorted by changing notions of chemical theory, during the past twelve decades. Williamson[35] in 1851 wrote:

"The experiments of M. Chancel, agreeing in result with my own, have clearly proved that the numerous family designated as hydrated oxides are t formed by the juxtaposition of an atom of water with an atom of metallic oxide, *e.g.*, $K_2O + H_2O$, but that the equivalent of the molecule is half that quantity, namely $\begin{matrix}H \\ — \\ K\end{matrix} O$; they are not compounds of water but products of substitution in water . . . alcohols, which are truly hydrated oxides, must be considered as products of substitution of the compound radicals, . . . for half the

At that time the compound radicals, or, as we should to-day term them, the alkyl radicals, and the alcohols as well, were considered basic in nature. This work of Williamson first brings out clearly the idea of hydroxyl compounds.

Roscoe[44] in 1873 definitely limits the application of the term:

"Viele basische Oxide verbinden sich mit Wasser zu einem Hydroxide." p. 153.

"Die im Wasser löslichen Hydroxide haben, wie schon früher erwähnt, eine alkalische Reaction." p. 154.

Kolbe[30] concurs in this view:

"The name hydrate includes two classes of bodies; the acid hydrates (the oxy- or sulpho-acids) and the basic hydrates (the hydrates proper)." p. 56.

Nuttall[38] is admirably definite:

"Hydroxide, a metallic hydrate." p. 185.

Richter[43] meets the issue squarely also:

"Some of the elements yield acids by their union with oxygen, or more correctly oxides, which form acids with water. Most of these are the metalloids. . . . With oxygen the metals usually yield oxides, which form hydroxides (hydrates) or bases with water." p. 84.

The "Century Dictionary"[4] supports this view:

"A metallic or basic radical combined with one or more hydroxyl groups, as potassium hydroxide, KOH: ethyl hydroxide, C_2H_5OH. Hydroxides may be regarded as formed from water (HOH) by the substitution for one of its hydrogen atoms of a metal or basic radical. An acid radical combined with hydroxyl is called an acid, the term hydroxide being reserved for basic compounds." v. 5, p. 2940.

The following quotations are taken from the fourth edition of Roscoe and Schorlemmer's "Treatise on Chemistry":[45]

"The acid-forming oxides combine with water to form hydrates which are termed acids." p. 261, v. 1.

"The basic oxides . . . form in combination with water a class of compounds termed hydroxides or hydrated oxides. . . ." p. 260, v. 1.

These quotations show that since the middle of the last century there have been extant and co-existent three well-defined and distinct concepts of the term hydroxide and that these three views persist to the present time, particularly in textbooks. In order to reach a decision as to which of these three definitions we should accept and [illegible] consider the historical

development of the term. In the course of this investigation we shall find it necessary to go back to the very beginning of modern chemical nomenclature and to examine the works of those men who laid the foundations of our science.

The word oxide was coined by a French chemist, de Morveau,[34] in 1787. This man of genius and insight formulated the first scientific system of chemical nomenclature with Lavoisier, Bertholet, and de Fourcroy. He was specific in his definition of the word oxide, and the meaning he gave it was generally accepted until the downfall of Berzelius' electro-chemical theory, when chemical theory was thrown into a state of flux, and the term oxide was extended to incldue the oxygen compounds of the non-metals. De Morveau says:

> "Nous avons donc dû chercher une expression nouvelle, & pour la rendre conséquent à nos principes, nous avons forme le mot *oxide*, qui d'une part rapelle la substance avec laquelle le métal est uni, qui d'autre part annonce suffisamment que cette combinaison de l'oxigène ne doit pas être confondu avec la combinaison acide, quoiqu'elle s'en raproche à plusiers égards." p. 56.

> "Après avoir établi la distinction des acides & des oxides métalliques, c'est-a-dire des métaux oxigène & des métaux simplement oxidés. . ." p. 58.

The acids are not oxides, according to this statement, but are compounds of oxygen with acid-forming elements. This curious distinction is based upon a difference in function of the resulting compounds and shows clearly the insight of the man in not confounding a similarity in process of preparation with a systematic likeness.

The next event of interest in development of the word hydroxide occurred twelve years after the coining of the term oxide. In 1800 Joseph Louis Proust* devised the word hydrate and applied it to the hydroxides of copper.

> "Le second est une combinaison particulière de l'oxide et d'une quantité fixe d'eau concrète, d'où dépend sa couleur, et que j'ai crû devoir nommer *hydrate de cuivre.*" p. 41.

Proust's concept of hydrates is identical with the most limited modern view of hydroxides. Contemporaneous chemists accepted the term and used it in this sense exclusively. The use of hydrate in place of hydroxide still persists at the present time, particularly in England, where the term was readily accepted. Proust had definite ideas about the hydrates; he felt that they were true compounds and, in defending this view, entered into that brilliant controversy with Bertholet which eventually firmly established the law of definite proportions. Proust says:

> "100 parties d'hydrate distilleés donnent 24 parties d'eau, 75 d'oxide noir (of copper), et la valuer d'un grain d'acide carbonique, étranger à cette combinaison, et qui s'y trouve par des causes que nous éclaircirons tout à l'heure." p. 43.

> "Dans l'hydrate de cuivre récent, il ne peut exister aucun soupçon d'acide." p. 43.

He subsequently developed the idea, and applied the term to other metallic hydroxides.[40, 41] In 1864, in answer to objections, he retorts that in the hydrates the water acts the part of an acid (p. 348), thus anticipating, by eight years, Berzelius, who is generally considered the father of that idea. His notions are well displayed in the following statements:

> "L'hydrate est, comme je l'ai fait voir antérieurement, la combinaison d'un oxide avec l'eau." ". . . je n'hesiterai point à assurer qu'il y a non-seulement des hydrates métalliques, mais même aussi des hydrates alkalines et terreux."

> "On ne peut nier aujourd'hui que la chaux ne se combine avec l'eau." p. 347.

Smithson,[47] reporting the analysis of some calamines, uses the term hydrate in accordance with the ideas of Proust:

> ". . . it seems to consist of two matters; carbonate of zinc, and a peculiar compound of zinc and water, which may be named *hydrate of zinc.*" p. 22.

Klaproth and Wolff[28] in 1810 reflect the definite concept of the term:

> "Proust first gave the name of hydrate to the combinations of metallic oxides with water." v. 2, p. 518.

John Davy[14] in 1811 refers to "hidrate" of potash, and Vogel[49] uses hydrate, both of them in the limited sense that Proust imposed upon the word. Humphry Davy[12, 13] did not accept the term, apparently, for he makes no use of it.

The first use of the term hydroxide eluded our search for months. It is evident that it could not have preceded the coining of

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* "*Recherches sur le cuivre,*" *Ann. de Chim.*, 1800, 32, 26-54.

the word oxide, which occurred in 1787, so with that as a lower limit a search of the literature was initiated which involved the scrutiny of every publication which might conceivably include the word. Cutbush[9] defined the term in 1821, and it was used by Henry[25] in 1823. Then it totally disappears from the literature until 1851, when it reappears in the "Catalogue of the Great Exhibition."[3] It is not used by Keis,[27], Chaptal,[5] Davy,[12 13] Dalton,[10] Silliman,[46] Cutbush in 1814,[8] Hare,[24] Gay Lussac,[18 19] d Aubuisson,[1] Vogel,[49] or Berzelius.[2] These papers cover a period of forty-two years, from 1791 to 1833, and, had the term been in wide use, would undoubtedly have included it.

The word hydroxide was coined in 1802 by Richard Chenevix,[6] who proposed it as a better form than Proust's hydrate, against which Chenevix urged some objections. He says:

"Hydro-oxide had been a much more proper appellation, as it would express the combination not of Hydrogen, but of water; which is the truth." p. 34.

"I have stated before that Hydro-oxide, or Hydroxide, would be the proper term for all combinations of metallic oxides with water; for such combinations as Copper, Cobalt, Nickel, and Uranium are capable of affording." p. 77.

A word concerning this man, now almost forgotten in science, who coined so widely used a term, may not be out of place here. Chenevix was born in Dublin, Ireland, in 1774, and died in Paris in 1830. When twenty-four years of age he published his first paper on a chemical subject, and for ten years was active in chemistry, publishing twenty-four papers in all until 1808, when he suddenly disappears from scientific literature. In the latter part of his life he was a successful dramatist and novelist.

He evidently did not possess sufficient personal influence to supplant Proust's hydrate with his term, for to the prestige of the professor at Madrid alone can we attribute the long survival of the former term. It was not until a great development in chemical theory and a fundamental change in point of view demanded a revision of our notions of the mechanism of water-combinations that the term hydroxide was firmly established in chemical terminology. Watts,[8] in 1864, and his third supplement, published as late as 1881, do not mention the term. From the start, however, an exemplary definiteness of meaning was attached to the term. Witness Cutbush:[9]

"Hydro-oxydates. Oxydes combined with water." p. 31.

"Hydro-oxydes. Oxydes combined with water." p. 31.

"Hydrate. A chemical combination of a body with water." p. 29.

"Oxydes. Combinations of oxygen with different bases, not possessing, strictly speaking, acid properties." p. 49.

"Sulphuric acid. . . A compound of sulphur and oxygen." p. 73.

and Henry:[25]

"The compounds of (metallic) oxides and water in which the latter exists in a condensed state, are termed hydrates, or hydro-oxides, or hydroxures." v. 2, p. 42.

In 1851,[3] after a disappearance of nearly thirty years from the literature, it still is used only for basic compounds:

"The whole coast of Andalusia is rich in galenas; the province of Malaga yields this product mixed with pyritic iron and hydroxidated iron, at Mijar." p. 1326.

"13. Hydroxide of iron, from San Claudio." p. 1327. ". . . . enveloping the bunches of hydroxide of iron." p. 1328.

These quotations make it clear that, in their original meaning, both of the terms, hydroxide and hydrate, connoted compounds of basic oxides with water or what we should to-day refer to as basic hydroxides. The original meaning of the word acid is clear, the oxygen compound which (dissolved in water) possesses acid properties. An acid is not an oxide, de Mourveau,[34] Cutbush,[9] and Hare.[24] The latter says:

"All the binary combinations of oxygen have been called oxides, when not acid." p. 209.

The correlative term base is equally clear. Cutbush defines it:

"Base A term used to express the earth, alkali, or metal, which forms a salt with an acid." p. 12.

The work of Williamson[53] made necessary some stated distinction between classes of compounds in which water exists as such and in which it exists in a rearranged form. The term hydrate was convenient and, although it had been applied by Proust and his contemporaries specifically to what we now term hydroxides, it had gradually been extended to include all compounds of water. Substances which contain water of crystallisation, hydrated compounds in which the water is patently present in something more than physical union, and even masses which were merely

moistened with hygroscopic water, were all *sub-summed in the category hydrate.* This state of affairs was not so serious while the Berzelian notions of chemical theory held the field, but, when the electro-chemical hypothesis was overthrown, the newer ideas demanded more definite conceptions of the character of water of hydration; more specific explanation of the way in which water is combined, and some way of distinguishing between compounds whose water may be readily driven off by heating and those which are unaltered by any heat or only by very high heat.

The hypotheses of acid water and basic water no longer were satisfactory; it was also evident that a great difference exists between water as combined in the alkaline hydroxides and as united in crystalline sodium sulphate. The term hydroxide began to be used again, but with rather indistinct meaning as denoting something in which water is combined more firmly than in the hydrates. Clarke[7] and Perkin[29] attempted to apply physico-chemical tests to compounds to establish a definite distinction between hydrates and hydroxides. The former determined the specific volumes of a large number of water-compounds, including hydrated salts and alkaline hydroxides. He found that the effect of combined water in the hydrated salts was nearly regular; that the mean value for the molecular volume of each molecule of water of crystallisation is 13.76, but that there is no such regularity observed in compounds in which, as we would now say, the hydroxyl group occurs. Perkin measured the magnetic rotatory power of many compounds and their hydrates, and came to the conclusion that if hydration increased the rotatory power by about unity the new compound is a hydrate.

The distinction between the two classes of compounds is, however, difficult to draw from such data and considerations. It is far simpler and more satisfactory to decide the question by analysis of the chemical relationships of the substance. Muir was led into the absurdity of deciding that cupric hydroxide is a hydrate, whereas arsenic acid (H_3AsO_4) is an hydroxide[35] by failure to observe this principle.

This mass of evidence may be summarised thus: The terms hydrate and hydroxide were originally synonymous and were specifically applied to basic hydroxides. The acids were not classed as oxides and the chemistry of the alcohols, phenols, and carbohydrates had not been developed, so that [illegible] of these compounds in the concepts. The term acid was confined to those oxygen-compounds which united with bases to form salts, and this statement also defined bases as those substances whose combination with acids produced salts.

The original conceptions of hydrates and hydroxides persisted until well past the middle of the last century; the term hydrate being gradually used in a more inclusive sense until, finally, the necessity of discrimination among the compounds of water forced action and the result was a muddling of both notions which has come down to us at the present day and constitutes the problem of this paper.

I think that there will be general agreement to-day that hydroxides are not to be regarded as water compounds; that type of substances may be characterised by the term hydrate. The characteristic of an hydroxide, then, must be content of hydroxyl, and our definition of the term will depend upon the modifications and limitations which we impose upon this concept.

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(*To be continued.*)

GENERAL NOTES.

BOARD OF TRADE ANNOUNCEMENT.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

APPLICATIONS FOR LICENCES IN SEPTEMBER.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during September, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 457, of which 311 were from merchants or importers. To these should be added the 34 cases outstanding on the 1st September, making a total for the month of 491. These were dealt with as follows:—

Granted—341 (of which 300 were dealt with within 7 days of receipt).

Referred to British makers of similar products—79 (of which 65 were dealt with within 7 days of receipt).

Referred to Reparation supplies available—30 (all dealt with within 2 days of receipt).

Outstanding on 30th September, 1923—40 (all dealt with at meeting of the Committee held on the 5th October).

Of the total of 491 applications received, 395 (or 80 per cent.) were dealt with within 7 days of receipt.

DYESTUFFS INDUSTRY DEVELOPMENT COMMITTEE.

The Board of Trade announce that they have appointed Dr. A. T. de Mouilpied, of the British Dyestuffs Corporation, Ltd., to be a member of the Dyestuffs Industry Development Committee set up under Subsection 2 (6) of the Dyestuffs (Import Regulation) Act, 1920, in the place of Dr. Herbert Levinstein, F.I.C., resigned.

REPORT OF OXYGEN RESEARCH COMMITTEE.

This Report* describes certain aspects of the work of the Oxygen Research Committee since its appointment in 1919. It deals chiefly with the technical difficulties which have hitherto restricted the commercial utilisation of liquid oxygen and liquid air, and describes in particular recent improvements in the methods of handling the liquefied gases on a practical commercial scale. The work of the Committee has been carried out principally in the Heriot Watt College, Edinburgh, and the Air Ministry Oxygen Laboratory.

* *Published for the Department of Scientific and Industrial Research, by H.M. Stationery Office. Price 8s. 6d. net.*

WIRELESS STATIONS IN RUSSIA.

A translation of a Decree of the Council of Peoples' Commissaries of the Union of Soviet Socialist Republics, dated July 4, and published in the " Izvestra " of September 12, regarding the installation of wireless stations by State, Trade Union, and Communist Party organisations in Russia, has been received by the Department of Overseas Trade from the British Commercial Mission, Moscow.

The Decree lays down the fundamental rules to be observed in connection with the construction and exploitation of wireless stations for special purposes which are stated to be industrial and commercial wireless stations, wireless stations for educational and scientific purposes, and amateur wireless stations.

The translation of the Decree may be seen by United Kingdom firms on application to the Department of Overseas Trade (Room 53), 35, Old Queen Street, London, S.W.1. (Ref. 8092/F.R./C.P.)

ALGERIA: MINING CONCESSIONS FOR SALE.

H.M. Consul-General at Algiers has received an enquiry for the names and addresses of British firms interested in the purchase and exploitation of mines in Algeria.

The enquiry indicates the existence of a calamine deposit with exploratory workings, in addition to deposits of lead, radioactive mineral, silver and phosphate containing 60 per cent. of phosphate of lime.

A geographical and descriptive Report (in French), with analysis, can be seen by interested British firms on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. D.O.T. 11620 F.E.)

FORMOSAN SUGAR CROP.

H.M. Consul at Tamsui has forwarded details of the first official estimate of the sugar production in Formosa for the season 1923-24, which allow for 6,031,951 piculs centrifugals and 153,578 piculs of brown sugar. The total estimate of 6,185,529 piculs would be equivalent to 365,255 tons. The area under cane is returned at 287,122 acres.

These figures, both for crop and area under cane, are below those put forward in the preliminary estimate. In the event of the present estimate being realised, the 1922-23 season's output will be exceeded by 230,731 piculs centrifugals and 47,519 piculs browns, or 278,250 piculs in all, and the forthcoming season will be second only in the results attained in the "record" year 1907, when the total production amounted to 7,634,903 piculs (450,841 tons).—(From the *Board of Trade Jurnal*, Octber 11, 1923.)

PHOTOMICROGRAPHY.

Photomicrography as an applied science is rapidly increasing in importance, and a knowledge of its technique has often proved of great value to works' chemists.

It is perhaps not sufficiently widely known that there exists in London a young and vigorous society devoted to the study and advancement of photomicrography.

The Photomicrographic Society holds its meetings at King's College, Strand, W.C., at 7 p.m. The programme for this session includes the following:—

Nov. 14: "High Power Photomicrography," J. E. Barnard, F.Inst.P., F.R.M.S.

Dec. 12: "General Methods in Photomicrography," E. Cuzner, F.R.M.S.

Jan. 9: "The Practical Use of Filters in Photomicrography," J. H. Pledge, F.R.M.S.

Feb. 13: "The Etching and Structures of Metals and Alloys," F. A. Ruddock, A.I.C.

Mar. 12: "Low Power Photomicrography," W. H. S. Cheavin, F.C.S., F.E.S., F.R.M.S.

April 9: "Photomicrography applied to Geology." Prof. W. T. Gordon, M.A.

May 15: Annual General Meeting and Exhibition.

In addition, informal meetings for discussion and demonstrations on photomicrographic matters are held at intervals.

A medal and a certificate are awarded annually, also a sum of money is awarded for the best advance in photomicrographic technique.

Although no definite instruction in photomicrography is given by the Society, it possesses to the full the "club spirit," and its members are anxious and willing at all times to help the novice.

Visitors are welcomed at the ordinary meetings, and cards of invitation and further information about the Society will gladly be given on application to the Hon. Sec., 1, *Hogarth Hill, Finchley Road*, Hendon, N.W.11. E. H. Ellis.

MACHINE OIL FOR SOUTH AFRICA.

Mr. W. G. Wickham, His Majesty's Senior Trade Commissioner in South Africa, reports that the South African Railways and Harbours Administration are calling for tenders to be presented by the 5th November, 1923, for the supply of machne oil. (Tender No. 477).

United Kingdom firms desirous of receiving further information regarding this tender should apply to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1, quoting reference 12290 E.D.C.C./2.(B).

Mr. W. G. Wickham, H.M. Senior Trade Commissioner in South Africa, reports that the same authority are calling for tenders to be presented by the 5th November, 1923 for the supply of antifriction grease. (Tender No. 478).

Reference, 12290/E.D./C.C./2.(C).

LINSEED OIL FOR SOUTH AFRICA.

The Tender Board of the South African Railway Headquarter Offices at Johannesburg are calling for tenders for the supply and delivery "ex. ship" of raw and double boiled linseed oil for the six months ending 30th June, 1924. (Tender No. 476).

A copy of the specification, general conditions of tender, etc., may be seen at the Department of Overseas Trade.

CHEMICAL INDUSTRY CLUB.

The Annual Dinner of the Chemical Industry Club will take place at the Connaught Rooms, on Friday, November 23.

Several men prominent in the chemical world will be present—names will be announced later.

Tickets, 15s. each, may be obtained from members, or from the secretary, 2, Whitehall Court, London, S.W.1.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE CHEMICAL SOCIETY.

ORDINARY SCIENTIFIC MEETING, THURSDAY, OCTOBER 18.

The following paper was read:—

Studies of Electrovalency. Part III.—The Catalytic Activation of Molecules and the Reaction of Ethylene and Bromine, by R. G. W. NORRISH.

SOCIETY OF GLASS TECHNOLOGY.

The first meeting of the Society for the session 1923-24 was held at Sheffield on Wednesday, October 17.

The Vice-Chancellor of the University of Sheffield, Sir W. H. Hadow, M.A., D.Mus., made the presentation of the "Frank Wood" Medal to the successful candidates, A. R. Sheen, B.Sc.Tech., and F. Winks, B.Sc.Tech.

The following papers were received and discussed:—

The Effect of Titania on the Properties of Glass, by A. R. SHEEN, B.SC.TECH., and PROF. W. E. S. TURNER, D.Sc.

The Estimation of Selenium in Glass, by A. COUSEN, B.Sc., A.R.C.Sc.

ROYAL MICROSCOPICAL SOCIETY.

A Conversazione was held at the Examination Hall, 8-11, Queen Square, Bloomsbury, on Thursday evening, October 11.

There were two Lantern Demonstrations:

Some Adaptations of Marine Organisms, by H. G. CANNON, M.A., F.Z.S., F.R.M.S.

The Material Basis of Heredity, by PROF. R. RUGGLES GATES, M.A., PH.D., F.L.S., F.R.M.S.

GENERAL EXHIBITS.

E. W. Bowell, M.A., M.R.C.S., L.R.C.P., F.R.M.S.: (a) Photomicrographs of Sections. (b) An improvement to the Automatic Microtome.

L. S. Day: Circulation in Newt.

E. H. Ellis, F.R.M.S.: Capsule of *Grimmia pulvinata*. Slides of Moss mounted in Glycerine Jelly.

George H. Gabb, F.C.S.: Eggs of the Powder Pest Beetle (*Lyctus brunneus*). (Exhibited for the first time.)

R. Ruggles Gates, M.A., Ph.D., F.L.S., F.R.M.S.: Comparison of Crossing Over-stages in Lactuca and Œnothera.

F. B. Gibhard: *Arrenhurus caudatus*.

L. G. Gilpin-Brown: Legs of *Syrphid Trophidia scita*.

H. Goullee: Entomological Specimens.

J. T. Holder, F.R.M.S., and Miss Holder: Eyes of Spider.

J. R. Leeson, M.D., F.L.S., F.R.M.S.: "The Fall of the Leaf."

R. J. Ludford, Ph.D., B.Sc., F.R.M.S.: Keratin Formation (Cornification) in Cancerous Growth of Mouse.

J. A. Murray, M.D., F.R.M.S.: Iron-Alum Hæmatoxylin Preparations (27 years old).

J. C. Myles: Diatoms.

H. W. R. Room, F.R.M.S.: Marine Hydrozoa (*Obelia geniculata*), showing Development and Liberation of Sexual Gooids.

J. Smiles and F. Welch: The Elements of Dark-ground Illumination.

C. Tierney, D.Sc., F.L.S., F.R.M.S.: "The Horrors of War."

E. E. Warr: Living Diatoms.

TRADE EXHIBITS.

R. & J. Beck, Ltd.: New form Museum Microscope. New form Dissecting Microscope, with and without Greenhough Binocular. New Apertometer. Aplanatic Ring Illuminator. Focussing Dark-ground Illuminator. Aquarium Microscope. Various forms of Microscopes and Apparatus.

The British Drug Houses, Ltd.: Microscopic Dry Stains and Solutions. Mounting Media. Indicators and Buffer Solutions. Comparator Case. Microscope. Slides stained with B.D.H. Standard Stains.

Chapman & Alldridge, Ltd.: A Non-Achromatic Microscope Sub-stage Con-

denser rendered *aplanatic* by the use of a *prolate spheroidal surface.* A device for centring Microscope Sub-stage Condensers whose iris diaphragms are situated between their principal focus and the condenser. A combined Microscope Objective and Dark-ground Illuminator for metallurgical work. A Vertical Thin Glass Illuminator for similar work. Specimens kindly prepared by Dr. Walter Rosenhain, and lent by the National Physical Laboratory. A new Microscope Focussing and Centring Sub-stage. New "Non-Flex" Microscope Stands.

The Edison-Swan Electric Co., Ltd.: Pointolite and Fullolite Lamps.

Flatters & Garnett, Ltd.: New Series of Slides, mounted in Euparal. British-made Stains in Tablet Form.

A. Gallenkamp & Co., Ltd.: Microscopes and Apparatus.

Kawksley & Sons: Microscopes and Apparatus.

Kelvin, Bottomley & Baird, Ltd.: Microscope Illuminant. Microscope. Optical Work in Quartz.

R. W. Munro, Ltd.: The Denne Photomicrographic Camera and Microscope.

Ogilvy & Co.: Mono-Binocular Microscopes, having Interchangeable Bodies. High-power Binocular Attachment for Monocular Stands. Low-power Binocular Dissecting Magnifier, having a large field of view. Ogilvy's Electric Microscope Lamps.

Rudolph & Beesley: "Reichert" New Darkfield Condenser. "Reichert" Changeable Condenser for Transmitted and Dark-ground Illumination. New "Reichert" Opaque Illuminator. "Reichert" Stereo-Inset. "Reichert" Microscopes and Accessories.

James Swift & Son, Ltd.: Medical, Mineralogical and Metallurgical Microscopes. High-power Binocular, Micrometer Microscopes, Gonimeters, Dichroiscopes, Photomicrographic Apparatus, etc.

W. Watson & Sons, Ltd.: Microscopes and Accessories. A new Immersion Dark-ground Condenser. New Condenser Mount, incorporating Centring Arrangement. A New Greenhough Binocular for Petrological Purposes. A New Microscope with Interchangeable Monocular and High-power Binocular Bodies.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The first Ordinary Meeting will be held on October 18, at 6 p.m., when Dr. A. Russell, M.A., D.Sc., President, will deliver his inaugural address.

A good programme of Ordinary Meetings and Informal Meetings has been arranged for the coming session.

BOOKS RECEIVED.

Organische Chemie, von Dr. Rudolf Pummerer. Pp. XI. + 209. 1923. Verlag von Theodor Steinkopff, Residenzstr. 12b. Dresden und Leipzig.

Molekulargrossen von Elektrolyten, von Dr. Phil u. Chem. Paul Walden. Pp. XI. + 350. 1923. Verlag von Theodor Steinkopff, Residenzstr. 12b, Dresden und Leipzig.

New Patents.

This list is specially compiled for *The Chemical News,* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

24023—Metallbank-und Metallurgische Ges.—Sulphur furnace. Sept. 26.

24166—Williams, J. G.—Manufacture of acid phosphate salts soluble in water. Sept. 28.

Specifications Published this Week.

181395—Lilienfeld, Dr. L.—Manufacture of cellulose ethers.

203812—Badische Anilin & Soda Fabrik.—Process for producing formic acid derivatives.

203975—Guillemin, J.—Appliances for the reduction of scoliosis and other bone deformations.

Abstract Published this Week.

202157—Dyeing cellulose acetate.—British Dyestuffs Corporation, Ltd., of 70, Spring Gardens, Braddiley, J., and Hill, J., of Crumpshall Vale Chemical Works, Blackley, both in Manchester, and Anderson, E. B., Mill Heys, Hemyock, near Tiverton, Devon.

Acid wool and substantive dyes, dyeing with; azo dyes, forming on the material.—Cellulose acetate silk is dyed by means of aminoazo dyes containing one or more carboxylic groups but not *sulphonic group, the amino group being diazotizable.* The dyes may be diazotized on the fibre, and developed with the usual components. A table is given, showing the direct shades and those deevloped with -naphthol, -oxynaphthoic acid, and p-aminodiphenylamine of the dyes obtained from the following components: m-aminobenzoic acid and o-anisidine, anthranilic acid, m-toluidine, -naphthylamine, 4-nitro-2-anisidine, *or 1:2-aminonaphthol ether;* anthranilic acid and o-anisidine; p-aminobenzoic acid and aminohydroquinone dimethyl ether; p-aminosalicylic acid and -naphthylamine; 5-acetylamino-2-amino-4-methoxytoluene and -oxynaphthoic acid, the product being hydrolyzed; m-aminobenzoic acid, p-xylidine, and m-phenylenediamine or -naphthylamine. The fibre is dyed in an aqueous dyebath, with or without the addition of weak acids or salts.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,

VOL CXXVII. No. 3315.

ARE THE NATURAL GROUPINGS OF THE ELEMENTS AND THE SPECTRAL LINES OF HYDROGEN RELATED?

PART I.

BY F. H. LORING.

It seems probable from Bohr's theory of the atom that there is a *place principle* involved, for the electrons automatically take up definite orbits when they are displaced outwardly, and on returning to their proper orbits definite wave lengths are revealed in the line spectrum then emitted, thus involving equally definite orbits. This is a very extraordinary phenomenon, and Bohr's formulation of the action by the use of Planck's quantum energy relation stands out as one of the great achievements of science.

It is very curious that the orbits should occur in definite places as due to definite quantised energy emissions, hence the term "place principle" stated above. There are, however, other phenomena involving a similar place principle as the present writer has touched upon in his book, "The Chemical Elements," published by Messrs. Methuen, and which is due to appear shortly. Mention may be made of several relative papers by the present writer, which appeared in this Journal under the title:—"Is there an element of zero atomic number?" In particular see this Journal, 1923, CXXVII., p. 225, and the references therein should be consulted.

The foregoing studies do not, however, bring out clearly the "principle" in question, but they do lead up to it. If it is now assumed that the wave-lengths of the five main lines of hydrogen give expression to five orbital places round the nucleus of the atom, in conformity with Bohr's work, then it may only be a step to regard the periodic table as made up of natural groups and groupings, as already discussed in these pages—see citations above—and that these groups represent similar places. An attempt is here made to show an exact connection between these two "place" ideas, but before doing so a brief elementary statement of the characteristic feature of the hydrogen emission lines will be given.

Balmer, in 1885, showed that these lines could be closely formulated, which leads to the following well-known calculation:—

Name of Line.	Wave Length.	Formula and Calc. Wave Length.
$H\alpha$	6563.04	$3646.13 \times 3^2/(3^2-2^2) = 6563$
$H\beta$	4861.49	$3646.13 \times 4^2/(4^2-2^2) = 4861$
$H\gamma$	4340.66	$3646.13 \times 5^2/(5^2-2^2) = 4340$
$H\delta$	4101.90	$3646.13 \times 6^2/(6^2-2^2) = 4102$
$H\epsilon$	3970.25	$3646.13 \times 7^2/(7^2-2^2) = 3970$

Referring to *The Chemical News*, 1923, CXXVII., p. 225, the five natural groups and groupings were given as 7, 9, 13, 21, 43.

The recent discovery of hafnium (= celtium, atomic number No. 72—there is a dispute as to priority of discovery of this element, so that one is facetiously inclined to think of it as "celtafnium") as an element closely allied to zirconium, by Coster and Hevesy (*Nature*, Jan. 20, 1923) makes it necessary to raise the "18 level" in the wedge table originally given in *The Chemical News*, 1922, CXXV., p. 386.

It will be seen that "17" then becomes a limiting number in the wedge system, so that hafnium may bear a secondary number 4 in order to complete the series to which it belongs to the limit 17. This will be made eivdent by referring to the table.

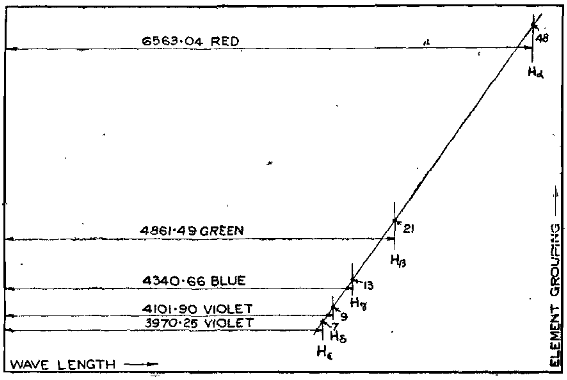
One is therefore driven to the supposition that there should be 4 elements immediately before hafnium, bearing secondary numbers 0, 1, 2, 3. This would raise the total number of elements in the large grouping to 47; but since the last wedge is incomplete from the view of limiting numbers, a blank should follow the place occupied by uranium of atomic number 92. This would then raise the number to 48. The necessity of a lacuna of atomic number 93 was shown in a paper by the present writer in *The Chemical News*, 1922, CXXV., p. 309.

Now, plotting the numbers 7, 9, 13, 21, 48 against wave lengths of the α to ϵ lines of hydrogen, taken as the main lines, gives a straight-line curve as depicted in the accompanying diagram, which is, by the way, carefully drawn, showing that the intersec-

tions are practically perfect. The wave length values, in Angstrom units, are selected from Sommerfeld's "Atomic Structure and Spectral Lines."

It will be seen that by raising the total number of elements in the large grouping, *i.e.*, from 44 to 48, introduces 4 extra elements not determined by the atomic numbers. At the same time the limiting numbers *throughout the wedge table necessitate* 4 additional elements preceding hafnium. The wedge table is so complete in every possible way, in that it does not violate the chemical ideas in connection with the elements whilst giving scope for the proper expansion of the rare-earth elements from Pr to Lu, that there must be something here worth careful study. If a suggestion may *be made, it seems possible that the 4 extra* elements have amalgamated with others of the series *involved, for they would probably* have properties already established earlier in the series; that is to say, in the first series starting with xenon.

The reader should not come to a hasty conclusion in these matters, as a very careful study of the elements at the places indicated is necessary. *In counting the elements in the large grouping, it should be noted that cerium belongs to this grouping,* and therefore it does not form one of the rare-earth 13. Cs, Ba, La, Hf, Ta, W, 75 and H belong also to this grouping. If the reader will refer to pages 14, 24, 28, 34, in the writer's book, "The Chemical Elements," this grouping will be made clearer.



NOTE ON HYDROGEN.

Inasmuch as the wedge table is made use of in this study, attention may be drawn to the group classification above given in connection with hydrogen as placed in the table. Hydrogen may be supposed to stand at the end of a very small steep wedge, so *that its level will, in conformity with* the other extreme levels of the respective wedges, approximate to that of fluorine, and thereby give it some characteristics that parallel well with those of the halogen elements. At the same time, hydrogen being over lithium, its electropositive character, due to the readiness with which it parts with its single electron, is accounted for.

Now this short high wedge should contain, besides hydrogen, an element coming into the inert group, but perhaps on a *slightly higher level, owing to the steepness* of the wedge. Since this extra element, regarded as the *zero-atomic-number member,* was discussed in the previous papers cited (see this Journal, CXXVII., p. 225), no further argument is called for here. This note however, shows that the wedge scheme is satisfactory, and therefore the significance of the "limiting numbers" made use of in

this study should be taken into account in probing the more obscure phase of the argument.

SUMMARY.

Plotting the values 7, 9, 13, 21, 48, at right-angles to the wave lengths of 5 main hydrogen lines gives a straight-line curve which suggests that the "place principle" of the main hydrogen orbits is fundamentally the same as the places in the periodic table as represented by natural groups and groupings containing respectively these numbers of elements in each; but a peculiarity develops at hafnium, which is discussed. It is shown that the wedge table throws some light on the problem involved in this study; and that hydrogen can be so placed, in conformity with the other elements and in no way an exception, that its two-fold property, so to speak, is accounted for. This gives the wedge table a greater usefulness and reliability in developing the argument that four extra elements may be merged or amalgamated with others so that they will have lost their separate identities.

AN EXPLANATION OF THE THEORY OF THE ROTATION OF THE ATOMIC NUCLEUS.

PART IV.

By HERBERT HENSTOCK.

OXIDES (*continued*).

(*Continued from Page* 243.)

The nitrogen octet is distorted, thus exhibiting no free valencies, but it may be easily opened up in the direction of the dotted lines, when bonds would be formed permitting other atoms to join the molecule, which explains the case with which this compound unites with oxygen.

It is often stated that nitric oxide is the most stable of the oxides of nitrogen, and with respect to the effects of heat this may be the case; but in its behaviour to the action of other atoms it is the weakest of the nitrogen oxides, as witness its spontaneous union with oxygen.

The halogens will unite with the positive edge (*a-d*), see Fig. 4, compounds of this nature being unstable (rule 2): oxygen will unite with the face *a-b-c-d* to form a double bond in NO_2, but there will then be two electrons at (*c*), which makes the bond a weak one (rule 6), with the consequence that the oxygen is easily detached.

Nitrogen tetroxide, in Fig. 5, the cubes representing nitrogen atoms.

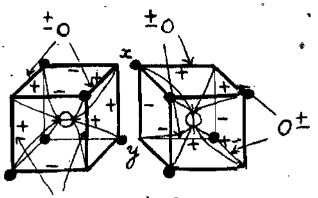
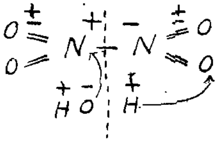


Fig. 5

The oxygen is united by double bonds as represented in Fig. 4.

There will be two electrons at *x* and two at *y* (Fig. 5), the single bond will therefore be weak (rule 6).

When this gas is dissolved in water, a mixture of nitrous and nitric acids is formed. If the explanation of this be written with the correct polarity signs included, the mechanism of the reaction becomes plain.



The OH unites with positive nitrogen and the hydrogen with one of the negative bonds of oxygen, the double bond between this and the other nitrogen becoming a single bond, a negative edge of the oxygen linking with a positive edge of the nitrogen.

Nitrogen tri oxide in Fig. 6.

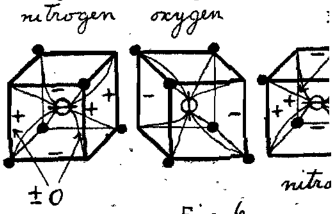


Fig. 6

Nitrogen pentoxide in *Fig.* 7.

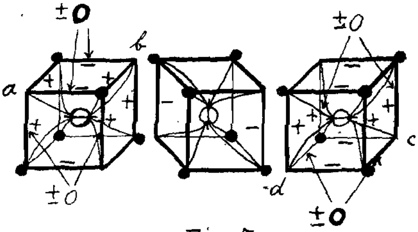
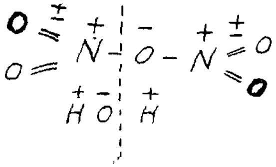


Fig. 7

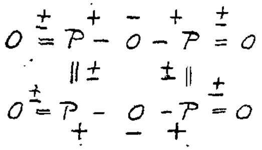
It will be seen that at *a* and *b* there will be two electrons, and the same thing applies to *c* and *d*, therefore the bonds uniting these two nitrogen atoms to the middle oxygen will be weak enough to be broken by water; thus:



Those bonds uniting the two oxygen atoms (marked dark) to the nitrogen will be weak, from the same cause, and these oxygen atoms are therefore the *nitrite* oxygen, which splits off to form nitrite.

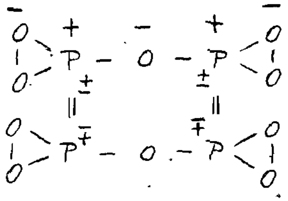
$$\overset{+}{H} - \overset{-}{O} - \overset{+}{N} \langle {}^{\bar{O}}_{O} = HNO_2 + O.$$

Phosphorus tri oxide is usually written P_2O_3, but the vapour density agrees with the formula P_4O_6, it will probably be constituted as follows:—



That is, it will be like N_2O_3 given above, but the molecule is doubled, a spare double bond being free in each nitrogen atom of N_2O_3, and this would apply equally to P_2O_3.

Phosphorus pentoxide, if it exists as such, will be like N_2O_5, see Fig. 7, but the *double molecule*, P_4O_{10}, will be probably



which can be easily seen on drawing out the octets.

The oxides of arsenic, antimony and bismnth will be constituted similarly to the oxides of nitrogen.

Chemical Research Laboratory,

School Gardens,

Shrewsbury.

SOME RECENT RESEARCHES IN ORGANIC CHEMISTRY.

By R. F. HUNTER, F.C.S.

(*Continued from Page* 245.)

Skri Krishna, and Pope, the first of these, condensation of m dimethylamino phenol with benzaldehyde included the preparations of 4 dimethylamino 2 hydroxy benzhydrol and a number of derivatives.

The second paper dealt with phenol citraconein, and included the preparation of K salt, tetra bromo derivative, and the diacetyl and dizenzoyl derivatives.

Another paper appearing about this time was one by Fargher and King on the additative compounds of antihyrylamino diacetic acid, the experimental part of which included the study of the salts of antihyrylamino diacetic acid, the additive compounds of anti-hyrylamino diacetic acid with neutral salts, the additiev compounds of the salts of anti-hyrylamino diacetic acid with neutral salts, and the preparation of the ethyl ester of anti-hyrylaminodiacetic acid.

Meanwhile the quantitative reduction by hydriodic acid of halogenated malonyl derivatives was being studied by Whiteley and West, the first part which concerned itself with the amides and S Dialkyl and aryl substituted amides of Mono and Di hromo malonic acid, appeared about ths time. The experimental work was of consderable magnitude. Bromomalonide, $CH\ Br\ (CONH\ Me)_2$, was prepared from malonamide, bromomalon dimethylamide, $Ch\ Br\ (CONH\ Me)_2$, was prepared from Malondimethylamide, bromo malondiethylamide, $CH\ Br\ (CONH\ Et)_2$, and the dibromo compound, $C\ Br_2\ (CONH\ Et)_2$, were obtained from Malondiethylamide. The corresponding compounds from malondi n propylamide, $CH\ Br\ (CONH\ Pr)_2$, and $C\ Br_2\ (CONH\ Pr)_2$, the bromo compound, $CH\ Br\ (CONH\ C_4H_9)_2$, from maloni n bulylamide, the iso compound from malondi isobutylamide, the compounds, $CH\ Br$-$(CONH\ CH_2Ph)_2$ and $C\ Br_2\ (CONH\ CH_2$-$Ph)_2$, from malondibenzylamide, bromomalonyl diurethane, $CH{\cdot}Br\ (CONH\ CO_2$-$Et)_2$, from malonylduirethane. A number of other bromo compounds were also prepared.

The reduction of ureides of mono and dibromo malonic acids by HI, and of bromo ketones by HI, were also studied.

From the same college (the Royal College of Science) appeared Naik's paper on the formation and properties of dithio ketones ($R_2C : S : S$) and di thio ethers ($R_2S : S$), which included the preparation of di thio mesonanilide, $(NH\ C_6\ H_5\ CO)_2$-$C : S : S$, its nitration, bromination, hydrolysis and reduction.

Other disulphide bodies were isolated.

About the same time, Pope and Smith's paper of S_2Cl_2, on substituted ethylenes, in which $\beta\beta'$ Dichlorodipropyl sulphide, $(C\ H\ Me\ Cl\ CH_2)_2S$ and $\beta\beta'$ dichloro-di-sec-butyl sulphide $(C\ H\ Me\ Cl\ CH\ Me)_2S$. were described, another paper on $\beta\beta'$ dichlordiethyl disulphide appeared by Bennet, in which the following were investigated:

Oxidation of $\beta\beta'$ dichlordiethyl sulphoxide to a sulphonic acid.

The preparation of monothio ethylene glycol, $SH\ CH_2\ CH_2\ OH$, of $\beta\beta'$ dichlorodiethyl disulphide and the oxidation of the disulphide.

Some experiments on the production of compounds containing arsenic as a centre of optical activity were described by Barrow and Turner, which necessitated the study of

γ Phenyl propyldimethylarsine;

Phenyl γ phenylpropylmethylarsine;

As - *Methyl tetra hydro arsinoline;*

Phenyl α naphthylmethylarsine and its oxide.

Hydroxy phenyl α naphthylmethyl arsonium d α bromo camphor II sulphonate;

Methyl ethylio do arsine;

Phenyl α naphthyl methyl allyl *arsonium* bromide;

Phenyl and naphthyl benzylmethyl arsonium bromide.

Three papers now appeared together: One on the action of alkyl nitrates on piperidine, by Gibson and Macbeth, in which the action of ethyl, propyl and butyl nitrate on piperidine was studied. The second was on Friedel Crafts Reaction, Migration of halogen atoms in the benzene nucleus, by Coisarow. The third was by Green and Price on the Chlorovinyl chloroarsines. Among the compounds investigated in this research were β Chlorovinyldichloroarsine, $CH\ Cl$:-$CH\ As\ Cl_2$, $\beta\beta'$ Dichlorodivinylchloroarsine $(CH\ Cl : CH)_2\ As\ Cl$, and $\beta\beta'\beta''$ Trichlorotrivinylarsine $(CH\ Cl : CH)_3\ As$.

In February, 1921, Kenner and Stubbings communicated to the Chemical Society's *Journal* a paper on the second form of 6 : 6' Dinitro diphenic acid and its conversion into new cyclic systems, in the experimental part of which were the preparations of 2-Chloro-3-nitrobenzoic acid.

γ 6 : 6′-Dinitro-diphonic acid;
6 : 6′-Diamino-2 : 2′-ditolyl;
γ 6 : 6′-diacetylaminodiphonic acid;
the di lactamo of γ 6 : 6′-diaminodiphenic acid and 1 : 10-dimethyl-5 : 6-naphtha iso-diazine.

The following month Morgan and Grist investigated their aryl sulphonyl naphthylene diamines and sulphonic acids, describing a variety of new compounds.

Meanwhile, a further research on residual affinity and co-ordination, reaction of selenium and tellurium acetyl acetones, appeared by Morgan and Drew, in the experimental part of which we have

Tellurium-O-ethylacetylacetone trichloride, CH_3 C (O C_2 H_5):C H C O CH_2 Te Cl_3, and its derivatives, and the reactions of selenium acetyl acetone.

This was followed by another paper on the action of S_2Cl_2 on ethylene, in which we get dichlorodiethyl trisulphide,

CH_2 Cl CH_2 S S S CH_2 CH_2 Cl,

Pseudo solutions of S in ββ′-dichlorethyl sulphide, and the study of the absorption of C_2H_4 by S_2Cl_2.

In March, 1921, Scott and Cohen's work on the carbamido acids and their hydantions appeared, in which the preparation of o-Acetyl-carbamidobenzoic acid, N H Ac-C O N H C_6 H_4 CO_2 H, and the corresponding o-Benzoyl carbamidobenzoic acid are described, and a fairly complete study of carbamidophthalic acid and its hydrantion is given. The action of sodium hypo chlorite, methyl sulphate, etc., on hydrantoin are described.

Papers have appeared on the Organic Derivatives of Thallium, by Goddard, in which thallium dimethyl carbonate, chromate, nitrate, thiocyamate, thallium, diethyl chromate and thallium diethyl trichloro acetate are described, and on organic derivatives of tellurium, the action of ammonia and alkalis on and dimethyl telluronium di iodide, by the late Richard Henry Vernon.

One of the series of papers on non-aromatic diazonium salts, 3 : 5-Dimethyl-iso-oxazole-4-diazonium salts and derivatives, by Morgan and Burgess, appeared at this time. Among the preparations we have 4-nitro-3 : 5-dimethyl iso oxazole 4-amino-3 : 5-dimethyl-iso-oxazole and its hydrochloride; 4-acetyl-amino-3 : 5-dimethyl-iso-oxazole,

C_5 H_6 ON. N H CO CH_3,

4-Benzylideneamino-3 : 5-dimethyl-iso-oxazole,

C_6H_5.CH : N C_5 H_6 O N.

4-o-Nitro-benzylideneamino-3 : 5-dimethyl-iso-oxazole,

NO_2.C_6H_4 CH : N. C_5 H_6 On.

3 : 5-Dimethyl-iso-oxazole-4-azoresorcinol, and 3 : 5-dimethyl-iso-oxazole-4-azo-β-naphthylamine.

A paper *by Fargher and Pyman on* 4 β methyl amino ethylglyoxaline appeared in May, 1921. The work was important, since 4 β aminoethyl glyoxaline is isolated from ergot, and is an intense stimulant of plain muscle. Among the experimental preparations were:

α-Chloro-β-glyoxaline 4-propionic acid d l-α-methyl amino β-glyoxaline-4-propionic acid, 4 β-methyl-amino ethyl glyoxaline di picrate and dihydrobromide.

Cohen's paper on hydrogenated quinolines is also worthy of mention, and describes the preparation and properties of a number of interesting substances.

May, 1921, saw another paper on studies in the camphane series, amino phenylamino camphor, by Forster and Saville.

In the experimental work we have the nitration of phenylamino camphor and the nitrosoderivative, p-amino-phenyl-amino camphor, derivatives of p-benzeneazophenyl amino camphor-p-sulphobenzeneazophenyl amino camphor and 4-amino-1-naphthyl amino camphor.

Two papers have appeared by Kipping and Sands on the organic derivatives of silicon, the first of which dealt with saturated and unsaturated silico hydrocarbono, Si_4Ph_8. They investigated the action of sodium on diphenylsilicon dichloride, and that of iodine on unsaturated silico hydrocarbon, giving octa phenyl di iodosilicotetrane $Si_4Ph_8I_2$.

The actions of tetra chloroethane and of boiling $C_6H_5NO_2$ on the unsaturated silico hydrocarbon were also investigated.

Their second paper was on the use of piperidine as an analytical reagent.

At the same time there appeared Davies two papers on the cumulative effect of chlorine atom and methyl and sulphonyl chloride groups on substitution in benzene nucleus. This necessitated some important preparations.

Davies *summarised his results in* something of this way:

The nitration of 2 chloro p toluene-sulphonyl chloride leads to 2-chloro-5-nitro-p-toluenesulphonyl chloride and 2-chloro-6-nitro-p-toluenesulphonyl chlorides. The proportion of these isomerides shows orientation due to chlorine atom is much greater

than united directive effects of methyl and sulphonyl groups. The sulphonyl group *and not the nitro is reactive in the 5-nitro*, and can be replaced by OH by boiling with dilute NaOH.

Monochlorination at 70° of chloro-p-toluene sulphonyl chloride leads mainly to 2 : 6-dichloro-p-toluene sulphonyl chloride.

The second paper contained the preparation of 6-chloro-o-toluene sulphonyl chloride, 6 *chlorosaccharin*, the *nitration of* 6-chloro-o-toluenesulphonyl chloride 6-chloro-3-nitro-o-toluenesulphonyl chloride gave 6-chloro-4-nitro-o-toluenesulphnoyl chloride.

Monochlorination of o-toluenesulphonyl chloride in presence of $SbCl_3$ leads to formation of isomerides 6-chloro-o-toluenesulphonyl chloride in 40 per cent. yield nitration at 25° of this results in production of 6-*chloro-4-nitro-o-toluenesulphonyl chloride* and the 3-nitro compound and the sulphonyl chloride is replaced by OH by boiling with NaOH solution.

Field's paper on mitragynine and mitraversine, two new alkaloids from species of mitragine is worthy of note. Published in conjunction with it was Stedman's New Degradation product of Physostigmine. At the same time, June, 1921, there appeared Brady and Bowman's research on Dinitro tolyl hydrazines, published at this time, and included the study of several nitrotoluene and hydrazine derivatives.

The first of Barnett's studies in the anthracene series appeared at this time, and included some unusual preparations such as 9 : 10-dhydro anthraquinyldipyridinium dibromide, on which the action of NaOH, NH_3, primary and secondary aliphatic amines, pyridine and quinoline, and primary and secondary aromatic amines was studied.

Published at the same time was a paper by Challenger and Allpress on organic derivatives of bismuth. Among some of the compounds prepared by these researchers were:

Di a naphthyl chlorobismuthine, the corresponding bromo compounds and naphthyl bismuthine dibromide, phenyldibromobismuthine, and *tri m tolyl bismuthine* and the action of Grignard reagents on various of these and other compounds was also investigated.

THE EVOLUTION OF CHEMICAL TERMINOLOGY.*

By James F. Couch.

(*Continued from Page* 253.)

The most inclusive definition of the term hydroxide is the statement that it denotes a substance which contains an hydroxyl group.

Defined in this way the class hydroxide will contain a very diverse collection of substances. In addition to the metallic hydroxides we shall include the oxy-acids, such as sulphuric acid and phosphoric acid and, of course, we must admit the acid salts, such as sodium bisulphate $NaO.SO_2.OH$, as well as the basic salts. Alcohols, phenols, the enol forms of tautomeric ketones must also be admitted. Resorcin, then, may be termed orthosalicyl hydroxide. All of the organic acids, both the carboxylic and sulphonic acids, belong in this class; we shall term formic and oxalic acids hydroxides. The hydroxy-acids, such as lactic acid, have a double claim to recognition as hydroxides owing to their content of two hydroxyl groups. The hydroxy-amines, hydroxy-pyridines, hydroxy-quinolines, and the derived alkaloids amidst the intricacies of whose constitutional formulas nestles an hydroxyl group, all come clamouring for inclusion. Nor can we bar out that great class of hydroxyl compounds, the carbohydrates from glycollic aldehyde, the simple biose, through the whole class to the complex cellulose, for the carbohydrates bristle with hydroxyl groups.

There are certain difficulties, however, which arise as a result of so wide an extension of the meaning of the term hydroxide. If all these substances are to be considered hydroxides, it follows that they must have names in conformance with this aspect of their constitutions. Systematic classification requires this. But an effort to satisfy that demand would lead us into absurdity and cause us to coin a large number of new names which would be of no other service than to bolster the theory. Sulphuric acid must become sulphuryl hydroxide; sulphurous acid, thionyl hydroxide; and what we should name thiosulphuric acid and tetrathionic acid is not very clear. Phosphoric

* [*Reprinted from "The American Journal of Pharmacy, Philadelphia, Pa., July,* 1923.]

acid would easily become phosphoryl hydroxide; but what should we name hypophosphoric acid? With the alcohols and phenols there would be no more than moderate difficulty; the organic acids, however, would not be so readily disposed of, and the carbohydrates would present a problem which is not at all pleasant to contemplate.

A more serious objection to the broad definition arises from the consequences to chemical theory. If we apply the term hydroxide to such a varying and heterogeneous array of substances, the concept hydroxide loses all specificity as a functional mark; it converts the term into a mere character and divests it of all practical value. The far larger portion of the substances enumerated is not chiefly characterised by the content of hydroxyl but the chemical properties depend upon other atomic complexes and the presence or absence of hydroxyl is frequently of very minor importance. The class loses most of its significance and its members no longer possess outstanding common properties.

The extension of the class to include all hydroxyl compounds serves no scientific or practical purpose. If the class cannot be considered a homogeneous unit, and it certainly cannot be so considered if it is to contain acids, bases, and alcohols, which have their own specific properties as classes, the utility of the term for either purpose is much impaired. If the members of the class do not exhibit certain properties which readily identify them as belonging to the category, and all of these various classes enumerated above do not fulfil this requirement, it is impossible to assign definite characters to the class, and consequently the significance of the class-term is destroyed.

From such considerations we must conclude that the extension of the term hydroxide to include all hydroxyl-compounds could have but one consequence, the worthlessness of the term. The second idea, that of allowing the term to embrace all hydroxyl compounds but of restricting its use to basic compounds, does not avoid the objections raised against the other inclusive idea and creates its own objection on the ground of vagueness.

There remains, then, the concept that an hydroxide is an hydroxyl-compound with basic properties. This most limited definition excludes the oxy-acids, the alcohols, the phenols, enol-ketones, organic acids, sulphonic acids, and all the rest of that galaxy admitted by the broad definition.

The first point in favour of this narrow view is the fact that this concept is the one which is held by the greater number of chemists at the present time. This, in itself, is no argument for the correctness of the concept, but it is an important consideration in a case like the present, where the preferableness of conflicting notions is being studied. It would be easier to get general agreement to this definition than to any other.

Although this narrow definition is supported by the historical data, an argument based upon whose facts will not be considered of first importance. We cannot consent to bind ourselves to the notions of a hundred and twenty years ago, for we know that those ideas of chemical relationships were inaccurate in the light of our present knowledge. We can, by such evidence, readily demonstrate that the term acid is misused to-day, and, indeed, that term has had many modifications of meaning since Lavoisier's time; but such an effort could not result in any real benefit to chemical nomenclature. Certainly, no general term is to-day used with more specificity of meaning than is the word acid. Consequently the historical facts, while important, cannot be considered final reasons for the acceptance of this narrow view.

A more important argument in support of this limited concept, however, is based upon functional relationships. Throughout chemical nomenclature the idea of functional similarities is most important in classification. The acid function is the only property shared in common by all the members of the large, perhaps the largest, chemical classification of substances, the acids. Diverse as their structure may be, various as their components are, differing most widely in physical properties, in solubility, in state of aggregation, yet all producing hydrogen ions under proper circumstances, whence hydrogen ion concentration comes to be the measure of acidity. The possession of this one function classifies the substance as an acid.

Is there a corresponding function which characterises an hydroxide? Unless we limit the term to the basic hydroxides, those which, when soluble, ionise to radical and hydroxyl ions in solution, it will be difficult to find one single common property among hydroxyl compounds. Reactions with phosphorus halides, which are of broadest application, will not suffice definitely to distinguish them in every case.

It appears likely that the confusion

which has arisen out of the idea that oxy-acids are hydroxides is due to lack of just this sort of consideration. This concept apparently had its beginnings at the time when chemical theory decided that water is necessary for the acid function and the natural analogy of both acidic and basic oxdes combining with water to form in the one case acids and in the other bases was too alluring for resistance. This conclusion was brought forward a few years before Arrhenius published its revolutionising theory; it is quite probable that, had the theory of ionisation been accepted first, no acid would ever have been termed an hydroxide. Happening in the other way, however, and in the face of the numerous new ideas consequent upon the electrolytic hypothesis, the study of water combination was neglected, and such imperfect ideas as had been formulated were allowed to stand unchallenged.

From no functional point of view, then, can an oxy-acid be considered to fall into the class of hydroxides. On the contrary, the very opposite properties of acids and basic hydroxides indicates fundamental differences in the nature of the combined hydroxyl groups. In the one case the hydroxyl group is split by ionisation, its hydrogen appears as hydrion, and its oxygen occurs in the anionic portion of the electrolyte. In the basic hydroxides the hydroxyl ionises as such.

Another fundamental distinction will become apparent if the mechanism of the reaction between ionised water and an acidic oxide is compared with that of ionised water with a basic oxide.

The same argument applies when we consider the alcohols as hydroxides. These, when they ionise, yield hydrogen ions only, neevr hydroxyl ions. For theoretical reasons they are sometimes considered as basic hydroxides, yet this concept cannot justify itself in the face of critical analysis. Many of the ideas we hold concerning the alcohols are the result of the pedagogical practice of comparing them with the alkaline hydroxides for the sake of impressing the facts of organic chemistry upon our student minds. True, we have a series of "salts" of the alkyl radicals and can match the more important mineral salts with examples from the organic compounds. But it is not difficutl to see that there is a fundamental difference between the two classes of substances. Methyl chloride, to consider a well-known alkyl "salt," is no chloride in the sense that sodium chloride is; it does not ionise to form chloride ions until it has first been hydrolysed. It is rather chloromethane, and this is the preferred terminology; the other name is retained for historical and commercial reasons.

In the phenols the hydroxyl group also lacks any basic function, and here, when there is any ionisation, hydrion and not hydroxyl ion is formed. The replacement of the phenolic hydroxyl by anions does not result in true salts. This is recognised in their nomenclature; we speak now of chlorobenzene, not of phenyl chloride, and of chlorophenol, not of salicyl chloride (which indeed would be a quite different substance).

In the hydroxy organic acids the hydroxyl has no basic functions whatever, and the consideration of these compounds as hydroxides would lead to such a cumbrous nomenclature that the Geneva system is much to be preferred. Yet these substances must be included in the class hydroxide unless we are to define it narrowly.

In the nitrogen organic compounds the presence of hydroxyl is always of minor importance. Where the hydroxyl is united with the ring nitrogen we have the pyridinium, quinolinium, etc., bases, which are true basic hydroxides, analogous with ammonium hydroxide. Hydroxyl, substituted in the ring, however, becomes phenolic and is no longer basic. The same situation occurs with those alkaloids which add water to the basic nitrogen atom to form true hydroxides; the hydroxyl so combined functions as an anionic group. When the hydroxyl is combined with carbon in the alkaloidal molecule it functions as a phenolic or as an alcoholic group.

The phenomenon of amphoteric hydroxides appears, at first glance, to present difficulties in the way of limiting the term hydroxide to basic compounds. The hydroxides of aluminium, zinc, chromium, lead, etc., dissolve in acids and in strong alkalies to form, in the one event, salts of the metal, and in the other, compounds which have been considerod metallic aluminates, zincates, chromites, plumbates, and so on. Creighton* has just reported the formation of metallic salts of cupric acid by the solution of cupric hydroxide in strong alkalies. As representative of this class of phenomena, with the possible exception of

* *J. Am. Chem. Soc.*, 45, 1237 (1923).

he last case, let us consider the case of aluminium hydroxide.

From the evidence it might be argued that aluminium hydroxide may behave either as an acid or as a base and, indeed, the term "amphoteric" was coined to describe just this condition. If there is any validity in such an argument we must postulate the dissociation of aluminium hydroxide in solution, however slight the concentration may be, into not only hydrogen and hydroxide ions, but into aluminium and aluminate ions. The mere statement of the logical consequences of the idea at once demonstrates that it is preposterous. No one will to-day question the conditions which follow the solution of aluminium hydroxide in strong acid. There is agreement that this process is analogous to the solution of any metallic hydroxide in a strong acid. This settles the question of the basic behaviour of aluminium hydroxide. What, then, shall we say about the solution of this substance in strong alkalies? If it develops an acid function we must postulate dissociation of hydrogen; if we wish to escape from this absurdity we are forced to deny the actual formation of sodium aluminate.

This is not, of course, the *impasse* that it appears to be. The way out of the difficulty lies in a criticism of our use of the word solution in this connection, and when we carefully consider this point we see at once that we cannot view the acid and alkaline "solutions" of aluminium hydroxide as qualitatively similar. There need be no question of hydrogen ion formation here at all, for we are really dealing with a two-phase system in which micels of aluminium hydroxide surrounded with an envelope of adsorbed sodium ions form the dispersed phase. In other words, the system belongs to colloid chemistry, and considerations of the formation of a sodium salt are quite beside the point. Aluminium hydroxide is a base, a weak base, to be sure, but a base, nevertheless, and it is peptised by sodium hydroxide.

The same reasoning may be applied to the "amphoteric" hydroxides of zinc, chromium and lead, which are dispersed in alkaline solutions and which the older chemistry considered might form compounds known as zincates, chromites, and plumbates. The case of cupric acid cannot, according to [illegible]eighton, be disposed of in this way, yet [illegible]akes no assumption of the dissociation [illegible]c hydroxide to form hydrogen ions, rather, that the cuprate ion receives its two negative charges from negative hydroxyl ions. This view cannot, of course, affect the truly basic character of cupric hydroxide.

But if we are to limit the term hydroxide to basic compounds, what term shall we use to designate the larger class included in the broader definition of the word? If we must have some way of designating all substances which contain hydroxyl groups, they may conveniently be referred to as hydroxyl compounds. This, indeed, describes them much better than the term hydroxide, for the first phrase refers definitely to a structural similarity just as the phrases carbon-compounds, nitrogen-compounds, or sulpho-compounds, do, and without binding us to any specific statement as to functional characteristics.

On the contrary, it may be urged that the term bases is sufficient for the basic hydroxides, and with some show of reason. The term base may, however, include substances which do not contain hydroxyl groups and which do not react with water to form them. Witness the "onium" bases, many of which do not form OH.

From all these considerations it appears that the greatest practical as well as scientific utility will be served by the limited concept of the term hydroxide.

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GENERAL NOTES.

GERMANY'S TRADE AND INDUSTRY IN SEPTEMBER.

The Commercial Secretary at Berlin (Mr. J. W. F. Thelwall) has forwarded to the Department of Overseas Trade a review of Germany's trade and industry during September.

The devastating effect of the occupation and separation of the Rhineland and the Ruhr district may now be seen in all branches of German industry. The heavy fall of the mark as a result mainly thereof caused a great increase in the prices of all materials and in wages; and as, owing to the too substantial and rapid currency depreciation, it was impossible for industry to obtain the requisite capital, the existing shortage of capital and credit in trade and industry was greatly accentuated in the month under review, particularly as the Reichsbank were compelled by circumstances to restrict the granting of credit still further. Partly for these reasons, and also owing to the heavy burden of taxation, the world's market prices were reached or exceeded in more and more spheres of trade and industry. The consequences were increased stagnation in sales and further restrictions of work.

The reports of the Chambers of Commerce show that, although further large portions of trade and industry have gone over to the system of calculating prices in gold marks, no final solution of the difficulties presented by the currency depreciation has been arrived at so long as a stable currency depreciation has been arrived at so long as a stable currency has not been created, enabling all branches of industry, including the retail trade, to fix prices on a stable basis and to ensure the counter-value for deliveries and services.

Mining.

In the Central German brown coal district the output increased as compared with the preceding month, which was affected by strikes. The demand for raw coal declined towards the end of the month. The production of wet press bricks came to a standstill in September. The call for briquettes was greatly restricted, so that it was necessary, in part, to produce for stock. Coal prices rose in the period from the 1st to the 10th of September in proportion to the advance in wages and salaries and, in virtue of the negotiations in the Reich Coal Council, were fixed on a gold mark basis as from September 17. In fixing wages, arbitration was twice resorted to.

In Upper Silesia the pit coal production fell off, as there were two less working days in September as compared with the preceding month. Strike movements in various pits also interfered with production. As in the other coal districts, the calculation of coal prices in gold marks was introduced in Upper Silesia as from September 17. Calculation in gold marks was urgently necessary, as the heavy losses resulting from the former paper mark prices, owing to the rapid currency depreciation, could no longer be borne by the pits. In consequence of an anticipated substantial rise in prices, the demand for coal increased at times, but, in general, it was exceedingly weak, mainly in view of the lack of working capital in industry and of the want of purchasing power on the part of household coal consumers.

Potash.

In the potash industry there were fewer sales than in the previous month. Shifts had, in consequence, to be dropped, and the dismissal of workers could no longer be avoided. Potash prices were repeatedly increased, but in no way kept pace with the advance in prices of all materials, fuel, and explosives, and with the rise in wages and salaries. Agriculture held back with orders on account of lack of money. Only sulphate of potash products could be sold to a certain extent to foreign countries, frequently, however, only at a loss in consideration of the position of the world's market prices. A large part of the production had to be taken into stock.

Petroleum.

In the petroleum industry the profits of the works declined in consequence of the increase in wages and costs. The degree of employment continued, however, satisfactory. Owing to long-dated contracts for delivery, sales are ensured for some time ahead.

Metal Industry.

The metal market was adversely affected by the general situation. German metal prices have, in part, risen above the world's market level. This applies specially to lead. The metal industry continued to limit its purchases and only to cover absolutely essential requirements, with the result that a minimum amount of business was transacted in the month under review.

Aluminium Industry.

In the aluminium industry in Lüdenscheid and neighbourhood, employment was poor. Inland and foreign sales were bad, as the purchasing power of the inland population has declined still further, and increasing foreign competition renders export more and more difficult. The Customs policy of foreign countries also hampered export. The same applies to other products of the Lüdenscheid finished metal goods industry.

Electrical Industry.

The position of the electrical industry became worse, particularly as the cutting off of the occupied territory has greatly restricted the market for its products. Customers could, in part, no longer raise the requisite capital for new orders. Practically no extensions of industrial plant and overland power stations are being carried out. Prices have exceeded those of the world's market.

Chemical Industry.

Foreign sales of chemical preparations have declined to an alarming extent. The existing stock of orders is considerably below that which is normally on hand, both as regards quantity and value. In the interests of the workers, restrictions of operations have, so far, not been introduced, though this will be difficult to avoid in the event of the continuance of present condi-

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Glass Industry.

...ment in the sheet and hollow ...try fell off. The shortage of ...al and the exceptionally high ... for bank credits rendered ... much more difficult. The ... to go over to calculation ...land and foreign sales, in-

consequence, were quite unimportant. Prices obtainable abroad were so low that the works were, in part, not even able to secure half the absolutely necessary inland price.

Paper Industry.

The position of the Berlin envelope industry became worse. Still fewer orders were received, and the number of workers, who had latterly been working only three days a week, had, therefore, to be again cut down. The shortage of money would not permit of any new purchases of raw materials. The available stocks, so long as they lasted, were, therefore, worked up. Wages rose very considerably. In consequence, it appeared doubtful whether it would be possible to continue work for even two or three weeks longer.

The entire German printing industry found itself in a serious position. All firms in the type-founding industry had been working short time since September 1, the majority only 24 hours. The position of the newspaper printing works was the most difficult. That of the jobbing and book printers was similar; it was only with the greatest effort that they were able to raise sufficient money for the payment of wages, salaries, and for the purchase of printing paper. Orders from abroad came in sparingly, as the chief markets, Switzerland, Holland and Scandinavia, owing to the general dullness of business prevailing there also, were no longer very capable of purchasing. There is no prospect of an improvement in the situation. It is more likely that further considerable restriction of work will have to be reckoned with in the immediate uture, as, in view of the difficul economic conditions generally, firms are no in a position to work for stock. Zincographic works also have been working half time for weeks; besides the curtailment of hours, dismissals have also had to be resorted to.

Leather Industry.

The prices for raw hides and skins advanced 40-50 fold, as compared with the preceding month, in proportion to the currency depreciation. As a result of the difficult financial conditions, only the mo necessary requirements were covered. The was a brisker demand solely for ox and co hides and calf skins. On the leather market business was stagnant practically the whole of the month. The position on the boot and shoe market was still worse, owing to the rapidly increasing price buyers were almost completely absent.

DISINFECTANT FLUID FOR SOUTH AFRICA.

Mr. W. G. Wickham, H.M. Senior Trade Commissioner in South Africa, reports that the South African Railway Administration are calling for tenders for the supply of disinfectant fluid during the period January 1, 1924, to June 30, 1924. (Tender No. 482.)

A copy of the tender form, specification, and conditions of tender is available for inspection by United Kingdom firms at the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. No. 12337 E.D./C.C. (2).

The South African Railway and Harbours are calling for tenders, to be presented by November 12, 1923, for the supply of red oxide paint in paste, during the period January 1 to June 30, 1924. (Tender No. 184.)

A complete set of documents comprising general conditions of stores contracts, tender form and specification may be inspected at the Dept. of Overseas Trade.

CHEMICALS (COAGULANTS) FOR SOUTH AFRICA.

The Rand Water Board are calling for tenders (contract No. 249) for the supply and delivery of 150 short tons, or alternatively 300 short tons, aluminium sulphate or alumino-ferric, on or before noon on Friday, November 9, 1923. Reference No. 12342/E.D./C.C./2.

BRITISH EMPIRE CANCER CAMPAIGN.

Progress of the Appeal.

By consent of the Ministry of Health and the Stationery Office, the organisers of the British Empire Cancer Campaign have acquired the right to publish the recently issued report of the Ministry of Health Committee on Cancer. This will shortly be available, and to be obtained free on application to the Secretary, British Empire Cancer Campaign, 19, Berkeley Street, W.1. Other literature in the form of leaflets, pamphlets, etc., is also available for distribution, and applications from all who desire information on the objects of the campaign will be readily complied with.

Preparations are well advanced for an intensive campaign throughout the country, which will be conducted through the local branches of the Red Cross, and will culminate in a "Cancer Week" to be held early in 1924.

An interesting feature of recent collections has been the ready response to appeals made from the stage by popular music hall artistes. The Holborn branch of the Red Cross has organised collections at the Holborn Empire and other music halls of the Gulliver circuit. Miss Marie Kendall, Miss Lucille Benstead, and other well-known performers have addressed their audiences during the interval, and altogether about £1,000 has been collected by these means in the past few weeks.

Subscriptions to the Campaign Fund continue to be received in a steady stream at the offices of the British Red Cross Society. A very much larger sum, however, is required if the aims of the Campaign are to be carried out speedily. Subscriptions should be sent to the Hon. Arthur Stanley, G.B.E., C.B., M.V.O., British Red Cross Society, 19, Berkeley Street, W.1, or to any of the branches of Lloyd's Bank.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL MICROSCOPICAL SOCIETY.

20, Hanover Square, London, W.1.

President: *Professor Frederic J. Cheshire, C.B.E., F.Inst.P.*

Hon. Secretaries: *Joseph E. Barnard, F.Inst.P., James A. Murray, M.D.*

The section of the Society which has been formed to deal with the Industrial Applications of the Microscope, and to assist in the development of Industrial Research in British Industries, held a meeting on October 24.

Programme.

7.0 p.m.—Exhibits and Practical Demonstrations of new and improved instruments and apparatus of interest to those engaged in the Industries and to Microscopists generally.

8.0 p.m.—Communications:—

Professor F. J. Cheshire, C.B.E., P.R.M.S., presided.

Mr. J. E. Barnard, F.Inst.P., F.R.M.S., delivered the first of a series of Lecture Demonstrations, which embodied a practical course of instruction in the Manipulation of the Microscope. Detailed syllabus of these lecture demonstrations may be had on application.

Lecture 1.—The work-table of a microscopist who requires an ever-ready equipment. Illuminants suitable for various classes of work.

Dr. Marie C. Stopes, D.Sc., Ph.D., F.L.S.: *The Microscopy of Recent Coal Research.*

Future meetings will be held as follows:

November 28: Dr. Sidney H. Browning, L.R.C.P., M.R.C.S., F.R.M.S., *The Application of the Microscope to Industrial Diseases.*

January 23: Sir Robert A. Hadfield, Bart., D.Sc., F.R.S., F.Inst.P., F.R.M.S., will preside.

Captain J. W. Bamfylde, *Some Failures in Steel as revealed by the Microscope and recorded by Photography.*

Mr. H. B. Milner, M.A., D.I.C., F.G.S., A.M.I.P.T., *The Use of the Microscope in the Petroleum Industry.*

GEOGRAPHICAL SOCIETY OF LONDON.

The next meeting of the Society will take place on Wednesday, November 7, at 5.30 p.m., when the following communications will be read:—

On the Skeleton of Iguanodon atherfieldensis *sp. nov., from the Wealden Shales of Atherfield (Isle of Wight), by the late* Reginald Walter Hooley, F.G.S.

[Dr. A. Smith Woodward, F.R.S., has consented to read this paper, and, by kind permission of Mrs. Hooley, the skeleton of *I. atherfieldensis* will be exhibited in the meeting room. Dr. Smith Woodward will probably contribute some general remarks on the genus *Iguanodon.*]

The Igneous Rocks of the Tortworth Inlier, by Prof. S. H. Reynolds, M.A., Sc.D., F.G.S.

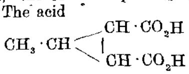
THE CHEMICAL SOCIETY.

Papers read at the Ordinary Scientific Meeting, held on October 18:—

The Chemistry of the glutaconic acids. Part XV.: *Three-carbon tautomerism in the cyclopropane series.* Part 2. By F. R. Goss, C. K. Ingold, and J. F. Thorpe.

Further experimental evidence was brought forward that the tautomeric relationship of the three isomeric esters of cyclic glutaconic acid is such that after the mobile hydrogen atom has passed into the carboxyl group, as in the enol-ester, it cannot return to the position which it takes up in the normal ester directly, but only by way of its position in the labile ester, *i.e.*, on the α-carbon atom of the system, which forms a halting place in the two stage migration.

In view of the apparent impossibility of reducing the acid to a saturated cyclopropane acid, the converse process has been studied. The acid



has been isolated in its three possible stereoisomeric modifications, and a double bond has been introduced into each. In each case the product is a cyclic glutaconic acid.

Studies of Electrovalency. Part III.: *The Catalytic Activation of Molecules and the Reaction of Ethylene and Bromine*, by R. G. W. Norrish.

The hypothesis was advanced that molecular activation is at least partly a catalytic process consisting in the polarising of the reactant molecule by association with the molecule of a polar catalyst, either in a gaseous, surface, or liquid phase. Lowry's view that the molecules of unsaturated organic compounds which are unreactive in their resting form may become reactive by developing an electro-valance in the double bond, is a special form of this hypothesis in which the complete ionisation of the bond is postulated. The hypothesis was tested by investigating the reaction between ethylene and bromine. The dried gases practically ceased to react when enclosed by "non-polar" walls of paraffin wax, but reacted rapidly when enclosed by a "polar" surface of glass, stearic acid or cetyl alcohol. The reactivity of the gases as measured by the bimolecular velocity constant varies with the chemical nature of the enclosing surface, being greatest for stearic acid. On passing dry ethylene and bromine, diluted with air, through a paraffined tube, and then through a glass tube, no ethylene dibromide was observed in the paraffined tube, while about 0.3 gm. collected in the glass tube.

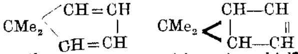
Selenium Trioxide and Chlorselenic Acid, by R. R. Le G. Worsley and H. B. Baker.

The action of ozone on dry selenium had already been shown to produce only the dioxide, but by the use of a solvent this agent has carried the oxidation a stage further and selenium trioxide has been isolated. The solvent used was selenium oxychloride, which when alone was unaffected by ozone. The solution of selenium in the oxychloride showed little or no apparent change by treatment with 7 per cent. ozone for 30 hours, but after this the trioxide separated

out in considerable quantity. Analysis showed 62.01 per cent. of selenium, SeO_3 requiring 62.26. The moleculer weight by lowering of the freezing point of phosphorus oxychloride was found to be 136. Selenium trioxide is a very pale yellow powder of density 3.6. It decomposes at 120° without melting or subliming. It dissolves in water with evolution of heat, but is insoluble in ether and other common solvents. It combines directly with dry hydrogen chloride, producing chlorselenic acid, which is very similar to chlorsulphonic acid. Analyses and molecular weight determinations confirm the existence of the new acid.

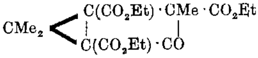
The Chemistry of Polycyclic Structures in Relation to their Homocyclic Unsaturated Isomerides. Part V.: *Orientation in the* gem-*dimethyl*-dicyclo*pentane series*, by R. C. Grimwood, C. K. Ingold, and J. F. Thorpe.

The proof adduced by recent experiments that derivatives of dimethyl*cyclo*pentadiene are tautomeric with corresponding derivatives of dimethyl*dicyclo*pentene, and that the nucleus of each substance of the series possesses two distinct phases which together confer on the compound a dual chemical character, raises certain problems of structure, principally relating to the orientation of attached groups, which require special methods for their solution.

(I) 

Thus there are two positions in which the sodio-ester might methylate on carbon.

It was shown that the substance has formula



PHYSICS IN THE TEXTILE INDUSTRIES.

The fifth of the series of public lectures on "Physics in Industry" being given under the auspices of the Institute of Physics will deal with this subject.

The lecture was delivered by Dr. A. E. Oxley, Physicist to the British Cotton Industries Research Association, at the Institution of Electrical Engineers, Victoria Embankment, London, on Monday, October 22, at 5.30 p.m.

The chair was taken by Sir Charles Parsons, K.C.B., F.R.S., who has just succeeded Sir J. J. Thomson as President of the Institute.

CORRESPONDENCE.

DOES CANADA PREFER FRANCE?

(From Lt.-Com. F. W. Astbury, M.P.)

To the Editors of The Chemical News.

Sirs,—Before the Overseas Premiers return from the Imperial Conference to their various Dominions, it would be useful if we could all come to a clearer understanding about the policy underlying the Franco-Canadian Convention, which came into force at the beginning of last month. The effect of certain concessions made by Canada in that agreement to France has been to reduce the preference on British goods as compared with French, a trading advantage which at the moment is being very considerably emphasised by the cheapness of the franc.

The first result of the situation is most interesting. A syndicate of French manufacturers have already set up in Canada a dye-house where grey goods imported under the Convention may be coloured in the Dominion. A needless blow, that is to say, is being delivered, not only at our textile trades, but at British dyestuffs precisely when this young industry is taking the road to real prosperity.

The frank opinion of the Imperial Conference upon the whole question would certainly be illuminating. New Zealand's views would in particular be valuable, for there a "depreciated currency duty" has just been adopted to allow Britons a reasonable chance of competing for business in British markets.—Yours, &c.,

Fred W. Astbury.

14, *St. Peter's Square, Manchester.*
October 15, 1923.

PROPORTIONALITY AND HEAT OF FORMATION.

To the Editors of The Chemical News.

Sirs,—Last year, Mr. Hawksworth Collins had a paper in *The Chemical News* (CXXV., 81 and 97), dealing with some thermo chemical data. In conjunction with some previous communications of mine, I would like to point out that the law he indicates is in application to compounds obtained as gases.

		Heat of Formation.
H>O (H, H)	3 v = 2	68,360
H—O, H—O (bonded)	4 v = 3	45,300

In water, the change of volume on combining is one-third, the gas volumes are 2 v H + 1 v O, and in hydrogen peroxide 2 v H + 2 v O. Before combining, a gas volume 4 would become less on combination should hydrogen peroxide behave similarly to water, as its heat of formation indicates. Should the reduction in volume be, say, one-fourth, from the similarity of structure of the compounds and in four volumes, 2 H + 2 O becoming 3 v hydrogen peroxide, the product of molecular weight and change of volume is $\frac{1}{4} \times 34 = 8.5$; in water it is $\frac{1}{3} \times 18 = 6$, and is sufficiently close in proportionality to the heats of these compounds as given in the above table.

It is sufficient to lend strong confirmation to the views expressed by Mr. Collins from the information in his table as applying to these compounds.—Yours, &c.,

J. C. THOMLINSON, B.Sc.

NOTICES OF BOOKS.

Radio-Activity, by K. FAJANS, Professor of Physical Chemistry in the University of Munich, translated by T. S. WHEELER, B.Sc., A.R.C.Sc.I., A.I.C., and W. G. KING. Pp. XII. + 138. Messrs. Methuen & Co., Ltd., 36, Essex Street, W.C.2. 1923. 8s. 6d. net.

The subject of Radio-Activity has developed, and is still developing so rapidly, that the treatises which gave the latest information on this Science a year or two ago are already incomplete. Prof. Fajans' volume, now translated into English by Messrs. Wheeler and King, although very complete in itself, comes as a kind of supplement to the earlier works on Radio-Activity.

The book, which is very readable and can be easily understood by all who possess an elementary knowledge of chemistry and physics, surveys the whole field of Radio-Activity. It opens with a study and classification of the Elements prior to the discovery of the radio-active transformations. The three radio-active series are then described, and an account is given of the chemical properties of the radio-elements.

There is also a short chapter on the Displacement Laws and their application. The significance of the isotopic varieties of lead as the end products of the disintegrations is overemphasised. Recent important work on isotopy in other elements, its detection by way of positive ray method, attempts to separate the α-carpes and their general properties ...ussed.

Prof. Fajans has himself made many valuable contributions towards the elucidation of the phenomena of Radio-Activity, but he has largely confined himself to an exposition of the results of others, and his name does not even appear in the index. The importance of his Monograph may be gathered from the fact that it has gone through four editions in the original (the translation is based on the fourth German edition), and should pass through several English editions.

The translation has been well done, the illustrations have been well chosen, and the publishers have done their part well.

BOOKS RECEIVED.

Kelly's Directory of the Chemical Industries. Pp. XXX. + 903. 1923. Kelly's Directories, Ltd., 186, Strand, W.C.2. 30s.

Treatise on General and Industrial Organic Chemistry, by DR. ETTORE MOLINARI. Pp. VIII. + 457 to 897. Second English Edition, Part II. 1923. Messrs. J. & A. Churchill, 7, Great Marlborough Street, W.1. 30s. net.

The Electron in Chemistry, by SIR J. J. THOMSON, O.M., F.R.S. Pp. 144. 1923. J. B. Lippincott Company, Philadelphia.

The Expert Witness, by C. A. MITCHELL, M.A., F.I.C. Pp. XV. + 188. 1923. Messrs. Heffer & Sons, Ltd., 4, Petty Cuey, Cambridge. 7s. 6d. net.

New Patents.

THIS list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

24495—Farbenfabriken vorm. F. Bayer & Co.—Manufacture of silicic acid gels. Oct. 2.

24367—King, P. H.—Method of retarding oxidisation in gums and resins. Oct. 1.

24477—Monterumici, R.—Preparation of magnesia hydrate. Oct. 2.

Specifications Published this Week.

204223—McDougall, I., and Howles, F.—Process for the manufacture of lead arsenate.

192376—National Aniline & Chemical Co., Inc.—Alkylation and aralkylation of carbazol.

197690—Soc. d'Etudes Chimiques Pour l'Industrie.

Abstract Published this Week.

amide of manures containing soluble organic nitrogen.

203709—Jouve, A. J. B., Helbronner, A., and Soc. Hydro-Electrique & Metallurgique du Palais.—Manufacture of chromates and bichromates.

—Process for the manufacture from cyan-

202016—Lignone derivatives; cellulose; sulphurous acid.—Cross, C. F., of 3, New Court, Lincoln's Inn, London, and Engelstad, A., of Vardol, Norway.

THE CHEMICAL NEWS,

VOL. CXXVII. No. 3316.

ARE THE NATURAL GROUPINGS OF THE ELEMENTS AND THE SPECTRAL LINES OF HYDROGEN RELATED?

PART II.

By F. H. LORING.

In this Journal of October 26, 1923, pages 257-259, the subject as indicated by the above title was tentatively discussed, it being shown that the α, β, γ, δ, ϵ series lines of hydrogen were directly related to certain natural groups and groupings of the elements represented by a series of five numbers, so that from these emission lines the said numbers could be derived. It is proposed to designate these groups and groupings by the above Greek letters, as shown in the scheme at the conclusion of this part of the paper. The scheme also serves to summarise the main features involved in this study.

The subject merits wider treatment, as, indeed, in principle it is a very interesting problem. Before, however, probing the matter further, the following corollary may be noted:—If the relationship in question holds, then one could say with some truth that the law of the part *is* the law of the whole, and therefore the hydrogen atom *is* a part of every element taken in the atomic sense; and Prout's hypothesis is true. The word *is* in this statement may carry an added meaning, such as, *is convertible into.*

Prof. Eddington, in his "Mathematical Theory of Relativity," gives expression to a significant idea, viz.: "This suggests striving for an ideal—to show, not that the laws of nature come from a special construction of the ultimate basis of everything, but that the same laws of nature would prevail for the widest possible variety of that basis."

This statement seems to be very significant, but be this as it may, the relationship shown clearly indicates that if it is true, then it should be the means of finding further interesting relations between the spectrum of hydrogen and the elements taken collectively. This, in fact, has been the case in a general way quite apart from this particular relation, as is instanced in the energy levels of an atom which become realised in other atoms by bombarding them with electrons. It must be remembered, too, that in the electron orbits of the hydrogen atom the major axes of the ellipses traced out in space are related to each other as the squares of numbers 1, 2, 3, &c., are; and, moreover, the X-ray spectra of the elements as found by Moseley stand in uniform step-wise relationship if the frequencies of the lines of the elements, taken consecutively according to their atomic numbers, are re-proportioned by taking respectively their square roots. In conformity with these relations the atomic numbers grow progressively by steps of one each time, beginning with hydrogen, and "the difference between the atomic weight [individual mass value] and the atomic number represents the number of electrons there must be in the nucleus [of the atom] in order to bring its net charge down to the atomic number"—to quote the words of B. Russell in his "A.B.C. of Atoms."

Furthermore, the Kossel-Sommerfeld law, which shows similar inner structures of the atom to be common to consecutive elements, means that a common type or system of atom building is involved; and from the foregoing this implies that hydrogen is the smallest positive unit in the architectural structure of the atom. Sommerfeld, in his "Atomic Structure and Spectral Lines," page 373, says: "We next assert *that the spark spectrum of each element is in structure the same as the arc spectra of the element that precedes it in the periodic system;* that is, that it consists of doublet, triplet, or so-called non-series lines, according as the arc spectrum of the preceding element is composed of doublets (like the alkalis), or triplets (like the alkaline earths), or of lines that apparently succeed one another without regularity (like most elements at the right of the periodic system, in particular the inert gases). Here we have enunciated the [*Spectral*] *Law of Displacement*, which, like the law of displacement of radio-activity, leads from one element of the periodic system to a neighbouring element. The meaning of our displacement law as applied to our model of the atom is obvious. Each column of the periodic system is, in general language, characterised by a certain valency; or, in our model, by a certain number of external electrons. On the other hand, we know that the line-structure of the spectra is, without exception, the same in each column of the series. If, now, the atom loses one electron by ionisation, then it becomes a member of the preceding column in its external behaviour,

and thus, as our law of displacement asserts, it will conform in the structure of its lines with the members of the preceding column; numerically, it will be best comparable with the element that immediately precedes it in the periodic system."

Enough has been said here to show how intimately the elements (atoms) are structurally connected; and whether the inert gases are allocated to the right or to the left of the table makes no real difference, since the table has to be considered as developed continuously. This continuity is shown by the radio-atoms which, in their change from one type to another, pass right across the table. The inert gases are, however, quite distinctive, as may be judged *from the above quotation, especially when* taking other factors into account. The grouping of the elements is a natural procedure, and it seems to have a certain counterpart in the line spectrum of hydrogen, as already indicated.

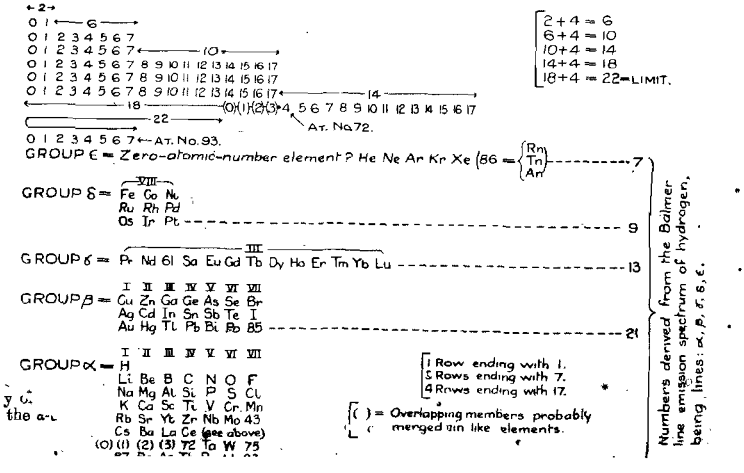
Considering the hydrogen lines, it is *known that those made use of in this study* are not in one sense pure lines, but that they are made up of fine-line companions. For example, the Hα line appears to have a certain complexity, which Sommerfeld has attributed *to a relativity effect*, since, according to this theory, the elliptical orbits rotate in their own planes, the nucleus occupying one foci—just as the planet Mercury describes an elliptical orbit round the sun, and it turns slowly in its own plane round this luminary as the pivot. The ellipse in this case is not a mathematically closed one, but it becomes a sort of *elliptical spiral*. The calculated wave lengths for the above line when reduced to vacuum figures are as follows:—

Hα Line.

6564.501
0.516
0.563
0.658
0.674
0.720

Apart from this ultra refinement, these Balmer series lines made use of in this *study stand out in strong contrast to the* general "background," by reason of their marked intensities. These intensities (B) taken advisedly from W. M. Watt's "Study of Spectra Analysis," 1904, p. 230, do not give an adequate idea of their development as now understood, but they will serve a general purpose of comparison with the corresponding group numbers (A), thus:—

A		B
48	———	20 α
21	———	20 β
13	———	15 γ
9	———	10 δ
7	———	8 ε



Interesting developments in connection ith the hydrogen lines seem to be fore-hadowed, but of more immediate interest ay be the following scheme which gives at glance the group system evolved by reason f this study.

NOTES RESPECTING THE SCHEME.

Referring to the wedge periodic table (see *'he Chemical News*, 1922, CXXV., p. 387; r the writer's "Atomic Theories," 2nd dition, frontispiece; or the writer's "The hemical Elements," pages 34, 107-110), which conforms with the above lay-out in very respect, Mn is on a lower level than Cl; imilarly, Ce is on a lower level than Zr, hile the element 72 (celtium or hafnium) ses to the level of Zr. This also suggests iat the overlapping at this part of the able is to be expected. The overlapping xtension, moreover, accounts for the tenency of a zero-valency member to appear i this part of the table, as has been the ase with some of the earlier schemes. Sir J. . Thomson claims to have found an inert as of atomic weight 163, but this is doubt-il, though the (0) member falls at about 57. See the writer's "The Chemical Ele-ients," pages 149, 150. Referring now to , this being on a short steep wedge, as al-eady explained in Part I., it is raised to the vel of F. Considering the "7" and "17" ements at the highest part of the edges, they are chemically alike, as istanced in the halogens which ccupy these extreme places as far as filled. 3 represents a lacuna not filled, for it is ased upon a minimum-production limiting-ries (see *The Chemical News*, 1922, XXV., p. 309), thus:—

	At. No.	Diff.
	93	
		2
Pa =	91	
		6
	85	
		10
	75	
		14
	61	
		18
	43	
		22
Sc =	21	

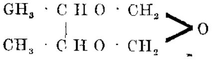
The small amount of Sc compared with a and Ti on each side of Sc supports this bservation; and it will be seen that the eries becomes a *limiting* one by reason of ie values of the differences shown. There ppears to be comparatively small quantities of Pa, and UX_2 which is an isotope, when considering the surrounding elements. The radio-isotopes, of course, are included in the atomic-number places characterised by the elements Ra, Ac, Th, &c.

DIACETYL ACETONE AND PSEUDO-CUMENE.

BY J. C. THOMLINSON, B.Sc.

A table giving all the proposed formulæ for diacetyl acetone would be too cumbersome in a short note of this kind.

The following ring structure,



is advanced for this substance, since it may be obtained by the oxidation of pseudo-cumene with chromic under suitable conditions:—

$$C_6H_3\,(CH_3) + 9\,O = C_6H_{12}O_3 + 3\,CO_2.$$

This oxidation is similar to that which takes place when alcohols are oxidised by chromic acid.

THE SALTS OF MALEIC, FUMARIC AND INACTIVE MALIC ACIDS.

BY JOHN MORRIS WEISS AND CHARLES RAYMOND DOWNS.

(*From the "Journal of the American Chemical Society," October*, 1923.)

In various investigations which had for their purpose the development of analytical methods for mixtures of maleic, fumaric and malic acids, a number of salts of these three acids were prepared and studied. The results are admittedly incomplete, and in certain instances the compounds deserve further study. We are presenting here the results obtained, regretting that we did not have the time to study all the compounds thoroughly, but hoping that others will do so. We wish to express our thanks to Dr. G. C. Bailey, Dr. H. E. Williams, and Dr. Wolesensky, for the careful work which they carried on under our direction in preparing and determining the formulæ and solubilities of a number of the compounds described, and to Mr. E. C. Buck for the very careful preliminary search of the literature which he made in this connection.

Ammonium Salts.

Analysis.—These salts were analyzed by distilling the material with an excess of standard sodium hydroxide solution and collecting the distillate in an excess of standard sulphuric acid. The distillate, titrated back with methyl orange as indicator, gave the ammonia content; and the flask residue, titrated back with phenolphthalein as indicator, gave the acid radical content.

Ammonium Fumarate.[1] — The product was best prepared by treating fumaric acid suspended in water with concd. ammonium hydroxide in slight excess of the calculated amount, concentrating in a vacuum at not over 60°, adding a little ammonium hydroxide to make up for losses in concentration and allowing the substance to crystallize. The crystals were filtered and washed with alcohol.

Analyses. — Calc. for $(NH_4)_2C_4H_2O_4$: NH_3,)2.67; $C_4H_4O_4$. 77.33. Found: NH_3, 22.55; $C_4H_4O_4$, 77.40.

The aqueous solution of the salt is stable at 60°, but when boiled it loses ammonia; 4.5506 g. of salt was dissolved in 200 cc. of water and the solution distilled, the distillate being collected in standard acid. In 50 minutes 0.08148 g. of ammonia distilled with 150 cc. water, representing 7.9 per cent. decomposition. On the addition and distillation of 150 cc. more water, 0.03933 g. of ammonia was volatilized (3.8 per cent.). The final limit of this decomposition or the product formed was not determined.

Ammonium Acid Fumarate.[2]—Fumaric acid was neutralized by two molecules of ammonium hydroxide with litmus as indicator and a second portion of fumaric acid equal to the first added. The mixture was fractionally crystallized into two lots of crystals, each equivalent to slightly more than ⅓ of the whole, the balance in the mother liquor being discarded.

Analyses.—Calc. for $NH_4C_4H_3O_4$: NH_3, 12.78; $C_4H_4O_4$, 87.21. Found: Fraction 1: NH_3, 11.70; $C_4H_4O_4$, 87.70; Fraction 2: NH_3, 12.70; $C_4H_4O_6$, 87.40.

Ammonium Maleate.[1, 3]—We were not able to obtain crystalline material by the same method as that used for ammonium fumarate. Under ordinary pressure, the solution does not lose ammonia by evaporation. Only a thick sirup results which ca[n] not be crystallized. When the solution [is] evaporated in a vacuum, the solid obtain[ed] is ammonium acid maleate. This salt d[e]serves attention by future investigators.

Ammonium Acid Maleate.[3]—This sa[lt] was obtained by the same method as d[e]scribed under the corresponding fumarat[e].

Analyses.—Calc. for $NH_4C_4H_3O_4$: NH_3 12.78; $C_4H_4O_4$, 87.21. Found: NH_3, 17.7[?]; $C_4H_4O_4$, 87.16.

Sodium Salts.

The sodium acid maleate[3, 4], sodium maleate[3, 4], sodium acid fumarate[5] and so[-]dium fumarate[2, 5, 6] were prepared by mi[x]ing the acids with the proper amounts [of] sodium hydroxide in water solution, allow[-]ing the salt to crystallize and drying it a[t] room temperature.

The data on water of crystallization a[s] given in the literature were confirmed b[y] ignition to sodium carbonate. In the cas[e] of the sodium acid fumarate, where ther[e] are no data, we found the crystallin[e] material to be anhydrous.

Barium and Strontium Salts.

Barium acid maleate,[3] barium mal[e]ate,[3, 7, 8] barium fumarate[2] and barium i[-]malate,[9, 10, 11] have been described. We di[d] not isolate these, but observed that a heav[y] white precipitate of slight solubility wa[s] obtained when a 10 per cent. solution o[f] barium chloride was added to a 10 per cent solution of either sodium maleate or fumar[-]ate. With sodium *i*-malate only a slight precipitate was formed.

Strontium acid maleate and strontium maleate[3] and strontium *i*-malate[11] have been prepared.

Strontium fumarate[2] has been described as containing three molecules of water of crystallization.

We prepared this salt by mixing strontium nitrate and sodium fumarate in water

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[1] *Keiser and McMaster, Am. Chem. J.*, 1913, XLIX., 84.

[2] *Rieckher, Ann.*, 1844, XLIX., 31.

[3] *Buechner, Ann.*, 1844, XLIX., 57.

[4] *Bodewig, Z. Kryst.*, 1881, V., 558.

[5] *Chandler, Jour. Am. Chem. Soc.*, 1908. XXX., 694.

[6] *Kannonikov., J. prakt. Chem.*, 1885, [2], XXXI., 321.

[7] *Kekulé and Strecker, Ann.*, 1884. CCXXIII., 170.

[8] *Vorlaender, Ann.*, 1894, CCLXXX., 177.

[9] *Kekulé, Ann.*, 1861, CXVII., 120.

[10] *Buisine, Compt. rend.*, 1888, CVI., 1426.

[11] *Duboux and Cuttat, Helvetica Chim. Acta*, 1921, IV., 735.

solution in equimolecular proportions, filtering off the precipitate and drying at 100° at which temperature it was anhydrous.

Analyses: —Calc. for $SrC_4H_2O_4$: Sr, 43.45; H, 0.99. Found: Sr, 43.25; H, 1.13.

CALCIUM SALTS.

The compositions were determined by igniting the salts to calcium oxide.

Calcium Acid Maleate[3] was prepared and found to correspond with the formula as given for 5 molecules of water of crystallization. With the neutral salt[3] the same coincidence was observed, this salt containing one molecule of water.

Analysis.—Calc. for $CaC_4H_2O_4.H_2O$: Ca, 23.25. Found: 23.28.

Calcium Fumarate[2 7 12] was prepared by precipitating a sodium fumarate solution with calcium chloride, and filtering, washing and air-drying the product. Our material corresponded to the trihydrate described in the literature.

Analyses. — Calc. for $CaC_4H_2O_4.3H_2O$: Ca, 19.23; H, 3.84. Found: Ca, 19.47; H, 4.01.

Calcium Acid Fumarate is not described in the literature. When a solution of sodium acid fumarate was mixed with a molecular equivalent of calcium chloride and evaporated, crystals were obtained which were separated and air-dried.

Analysis. — Calc. for $CaC_8H_6O_8.2H_2O$: Ca, 13.06. Found: 13.22.

Calcium Acid i-Malate[13] is stated to contain one molecule of water of crystallization. Our preparation was made by heating 52.8 g. of *i*-malic acid with 20 g. of calcium carbonate, filtering the solution, allowing it to crystallize, and separating and air-drying the crystals; yield, 64 g. The substance was found to be the anhydrous salt.

Analysis.—Calc. for $CaC_8H_{10}O_{10}$: Ca, 13.06. Found: 12.85.

MAGNESIUM SALTS.

Magnesium acid maleate, magnesium maleate,[3 14] magnesium fumarate[2] and magnesium *i*-malate[11] have been described. These salts were not prepared, but note was made that none of the three acids is precipitated from its sodium salt solutions (10 per cent.) by soluble magnesium compounds. In an attempt to produce the *i*-malate, magnesium oxide was dissolved in *i*-malic acid. On concentrating the filtered solution a syrup was obtained which did not crystallize, but solidified on standing to a hard white mass.

COBALT SALTS.

Cobalt Maleate is not described in the literature.

Cobalt was precipitated as carbonate from a solution of its nitrate and the latter filtered, washed and suspended in water. An equivalent quantity of maleic acid was added and the solution filtered and evaporated.

Analysis.—Calc. for $CoC_4H_2O_4.11H_2O$: Co, 15.90. Found:[15] 15.80.

Cobalt Fumarate[2] is stated to correspond to the formula $CoC_4H_2O_4.3H_2O$; this we were unable to confirm. Using concentrated solutions of cobalt nitrate and sodium fumarate, a copious, crystalline, pink precipitate was obtained. This was washed and air-dried.

Analyses.—Calc. for $CoC_4H_2O_4.4H_2O$: C, 19.59; H, 4.08; Co, 24.07. Found: C, 20.36; H, 3.86; Co, 23.93.

When the pink compound was dried at 100° it became somewhat bluish from loss of water.

Analysis. — Calc. for $CoC_4H_2O_4.2H_2O$: Co, 28.23. Found: 28.62.

Cobalt i-Malate.—This is not described in the literature. It was prepared by treating cobalt carbonate suspended in water with the calculated amount of *i*-malic acid and evaporating the mixture to dryness at 100°. The formula seems to be that of a trihydrate.

Analyses. — Calc. for $CoC_4H_4O_5.3H_2O$: C, 4.08; H, 24.07; Co, 19.59. Found: C, 4.15; H. 23.40; Co, 19.28.

NICKEL SALTS.

The nickel was determined by digesting a sample with concentrated ammonium hydroxide, adding water, a small amount of sodium iodide (0.02—0.05 g.), a few drops of standard silver nitrate solution and an excess of standard sodium cyanide solution. The excess was titrated back with silver nitrate to a slight permanent precipitate.

Nickel Fumarate[2] is stated to contain 4 molecules of water of crystallization. The salt was prepared by mixing dilute solutions of nickel nitrate and sodium fumarate and concentrating until a green crystalline pre-

12 *Carius, Ann.*, 1867, CXLII., 129.

13 *Bremer, Ber.*, 1875, VIII., 863.

14 *Walden, Z. physik. Chem.*, 1887, I., 529.

15 *Cobalt was determined by ignition to cobaltous cobaltic oxide*, Co_3O_4.

cipitate was formed, and removing soluble materials by repeated boiling with water.

Analyses.—Calc. for $NiC_4H_2O_4.4H_2O$: Ni, 24.08; calc. for $NiC_4H_2O_4.5H_2O$: 22.43. Found: 23.42.

If the precipitation of the nickel fumarate is carried on in concentrated solution, a different product seems to be formed.

Analyses.—Calc. for $NiC_4H_2O_4.5H_2O$: C, 18.27; H, 4.56; Ni, 22.43. Found: C, 18.44; H, 4.06; Ni, 22.30.

Nickel Maleate[3] resembles the fumarate in general properties, but appears to be more soluble. This compound was not analyzed.

Nickel i-Malate is not described in the literature. It is extremely soluble in water and, therefore, cannot be precipitated. If nickel carbonate is dissolved in malic acid a green solution is obtained, which, on concentration, forms a jelly. On long standing at room temperature, the sample lost water and crystals began to appear. This compound was isolated but not analyzed.

MANGANOUS SALTS.

Manganous Acid Maleate.—This compound has not been previously described; 69.6 g. of maleic acid was dissolved in the minimum amount of water at 30°, and to this was added 34.6 g. of manganese carbonate. A solid separated which was dissolved by warming it. As the solution was cooled in ice water, a granular pink precipitate was formed which was filtered, washed, recrystallized from water, and dried at room temperature; yield, 32.5 g.

Analyses.—Calc. for $MnC_8H_6O_8.4\frac{1}{2}H_2O$: C, 25.60; H, 4.20; Mn, 15.02. Found: C, 25.37; H, 3.91; Mn, 15.19.

From examination of the crystals microscopically, it appears that the salt is stable in the air and in a vacuum over sulphuric acid.

Manganous Maleate has not been previously described. It was prepared in the same manner as the acid salt, except that twice as much manganese carbonate was used. It appears to be stable at 100°. In dil. water solution it decomposes with the formation of manganese dioxide.

Analyses. — Calc. for $MnC_4H_2O_4.3H_2O$: C, 21.53; H, 3.58; Mn, 24.64. Found: C, 21.01; H, 3.31; Mn, 24.48.

Manganous Fumarate[2] has been stated to have the formula $MnC_4H_2O_4.3H_2O$. Our results did not confirm this. To 11.55 g. of manganese carbonate we added 11.6 g. of fumaric acid. The slight excess of carbonate was filtered off and the filtrate evaporated until a precipitate appeared, at first flocculent and then granular. This was filtered off and dried at room temperature.

Analyses.—Calc. for $MnC_4H_2O_4$: C, 28.41; H, 1.18; Mn, 32.54. Found: C, 27.55; H, 1.42; Mn, 32.02.

ZINC SALTS.

Zinc was determined by ignition to zinc oxide.

Zinc Acid Maleate[16] was not prepared.

Zinc Maleate[3] was made by quickly mixing a saturated maleic acid solution with zinc carbonate as a paste in a mortar and filtering before the zinc maleate separated. Zinc maleate formed as a white, granular precipitate which was washed and dried at room temperature.

Analyses.—Calc. for $ZnC_4H_2O_4.2H_2O$: C, 22.80; H, 2.78; Zn, 30.42. Found: C, 21.78; H, 2.78; Zn, 30.68.

When a solution of zinc maleate is heated, it decomposes giving a flocculent precipitate.

Zinc Fumarate[2] has been described in two modifications with 3 and 4 molecules of water, respectively. Our product was made by treating a suspension of fumaric acid with an excess of zinc carbonate in a mortar, filtering the mixture and evaporating the filtrate until crystallization began. Colourless crystals were obtained and dried at room temperature.

Analyses.—Calc. for $ZnC_4H_2O_4.5H_2O$: C, 17.81; H, 4.45; Zn, 24.26. Found: C, 17.24; H, 4.25; Zn, 24.42.

IRON SALTS.

Ferric Maleate[3] has been described as an indeterminate smear. On evaporation of a mixture of two molecular equivalents of ferric hydroxide and three molecular equivalents of maleic acid a dark, nearly black, amorphous mass was obtained which was dried at 100°. When analyzed this showed approximately the composition of the dihydrate.

Analyses.—Calc. for $Fe_2(C_4H_2O_4)_3.2H_2O$: C, 29.4; H, 2.04; Fe, 22.88. Found: C, 27.34; H, 2.59; Fe, 22.90.

In solution this material seems to be able to hold an excess of ferric hydroxide.

Ferric Fumarate[2] could not be prepared from ferric hydroxide and fumaric acid.

Ferric i-Malate[17] was not prepared, but considerable work was carried on with ferric

16 *Richter, Z. Chem.*, 1868, XI., 449.

17 *Pickering, J. Chem. Soc.*, 1914, CIII., 1358.

ammonium i-malate. One molecular equivalent of ferric hydroxide (precipitated cold because when precipitated hot it did not dissolve properly) was mixed with a clear solution of 2 molecular equivalents of malic acid and the mixture was heated to 60°. One molecular equivalent of ammonium hydroxide was then added, and the mixture heated rapidly to boiling. The work was carried on in semi-darkness as the material is light sensitive. A clear, red-brown solution resulted which was cooled rapidly in an ice-bath. t showed no ferrous iron when tested with ferricyanide solution. The solution was not stable even in the dark, as ferrous iron appeared on standing and gradually increased. When a thick solution was painted on glass and dried in a dark closet at room temperature a solid similar to ferric ammonium citrate was produced which contained no ferrous iron. When it was dried between 30° and 40° some reduction took place.

To compare the sensitivity of ferric ammonium malate and citrate, dilute solutions of each, free from ferrous iron, were placed in sunlight and tested for ferrous iron. After 5 minutes the malate showed a faint test for ferrous iron and after 10 minutes a very positive test, while the citrate was negative at 24 minutes and showed a positive test only after 39 minutes. In the dark at 100° after 5 minutes the malate showed ferrous iron, while after 20 minutes the citrate still tested negatively.

Attempts to produce ferric ammonium maleate or fumarate in the same way were unsuccessful.

COPPER SALTS.

Copper was estimated volumetrically in acetic acid solution by means of sodium iodide and thiosulphate.

Copper Fumarate[2, 12, 18] has been described both as a dihydrate and trihydrate. We obtained our material by precipitating fumaric acid with copper sulphate. The pale blue precipitate was washed and dried at 100°.

Analyses. — Calc. for $CuC_4H_2O_4.2H_2O$: C, 22.47; H, 2.80; Cu, 29.78. Found: C, 21.70; H, 3.06; Cu, 29.45.

Copper Maleate[8, 18] was prepared by precipitating a solution of equimolecular equivalents of copper sulphate and maleic acid with sodium carbonate. A deep blue crystalline precipitate formed which, as stated by the previous investigators, is the monohydrate.

Analyses.—Calc. for $CuC_4H_2O_4.H_2O$: C, 24.54; H, 2.04; Cu, 32.50. Found: C, 24.05; H, 2.39; Cu, 32.22.

Copper i-Malate has not been described. When equivalent quantities of copper carbonate and *i*-malic acid solutions are mixed and the mixture is evaporated, a hard vitreous blue mass is formed, which after several weeks becomes crystalline. It contains at this stage 25.02 per cent. of copper, which indicates a trihydrate (25.49 per cent. of copper). On continued exposure, the mass becomes paler blue and shows the presence of 25.70 per cent. of copper.

Analyses. — Calc. for $CuC_4H_4O_5.2H_2O$: C, 20.72; H, 3.45; Cu, 27.28. Found: C, 20.86; H, 3.16; Cu, 25.70.

This formula is quite doubtful and further work is indicated.

CADMIUM SALTS.

Cadmium salts of maleic and fumaric acids have not been described in the literature. Cadmium was determined by igniting the salt to the oxide, CdO, in a stream of oxygen.

Cadmium Fumarate.—Prepared by precipitating sodium fumarate with cadmium chloride in concentrated solutions this forms a copious, finely divided, white precipitate. It was filtered, washed and dried at 100°.

Analyses. — Calc. for $CdC_4H_2O_4$: C, 21.20; H, 0.88; Cd, 49.57. Found: C, 21.63; H, 1.18; Cd, 49.29.

Cadmium Maleate.—This was made by mixing equimolecular proportions of cadmium chloride and sodium maleate in solution and evaporating to crystallization. The salt was washed repeatedly with hot water and dried at room temperature.

Analyses. — Calc. for $CdC_4H_2O_4.2H_2O$: C, 18.29; H, 2.28; Cd, 42.75. Found: C, 17.76; H, 2.27; Cd, 42.50.

The salt retains sodium chloride tenaciously and needs exhaustive washing to purify it.

ANTIMONY SALTS.

No literature references were found to these salts, and all attempts to form the maleate, fumarate or *i*-malate by dissolving antimony trioxide in the corresponding acid were unsuccessful. In the case of *i*-malate, some oxide is dissolved (never more than 21 per cent. of that calculated), but apparently

[18] *Pickering, J. Chem. Soc.*, 1912, CI., 174.

an excess of acid is required to prevent hydrolysis so that the salt cannot be isolated.[19]

Sodium Antimonyl i-*Malate*.—Attempts were made to prepare this salt by heating 40 g. of sodium hydroxide, 144 g. of antimony trioxide and 134 g. of *i*-malic acid in water solution under a reflux condenser. After 15 hours, 82.8 g. of antimony trioxide remained undissolved. This was removed, dissolved in potassium acid tartrate and reprecipitated, washed and added again to the mixture. In this way all but 31 g. of the original quantity was finally dissolved, and all attempts to increase this failed. The final solution was evaporated to a thick syrup which, on seeding, solidified to a white, hard mass. It can be powdered, and is apparently stable and very soluble in water. The problem of these complex salts is interesting and deserves further work.

LEAD SALTS.

Lead was determined gravimetrically as the chromate or by titrating excess of dichromate with sodium iodide and thiosulphate.

Lead Fumarate[2] is stated to occur as the dihydrate. When equimolar quantities of lead nitrate and sodium fumarate were mixed in aqueous solution, fine crystalline flakes were obtained which were filtered and dried at 100°.

Analyses. — Calc. for $PbC_4H_2O_4$: C, 14.91; H, 0.62; Pb, 64.48. Found: C, 14.48; H, 0.88; Pb, 64.22.

Lead Maleate[3, 20] is stated to occur as the trihydrate. When we prepared it in a manner similar to that used for the fumarate, we obtained the anhydrous salt.

Analyses. — Calc. for $PbC_4H_2O_4$: C, 14.91; H, 0.62; Pb, 64.47. Found: C, 14.94; H, 0.78; Pb, 64.20.

Lead i-*Malate*[21] is the subject of varying opinion, being reported as anhydrous, with 1½ molecules water and with 3 molecules water. This salt was obtained as a white precipitate by interaction of lead nitrate and sodium *i*-malate in aqueous solution. When heated to 100° it softens to a dough-like mass. Its formula is doubtful but seems to approach the composition $PbC_4H_4O_5.{}^1/_2H_2O$.

Analyses.—Calc. for $PbC_4H_4O_5.{}^1/_2H_2O$: C, 13.78; H, 1.43; Pb, 59.48. Found: C, 11.91; H, 1.46; Pb, 59.42.

SILVER SALTS.

Silver was determined as the chloride.

Silver Maleate[3, 7].—This was formed by precipitating silver nitrate solution with sodium maleate and was obtained as a white precipitate which was dried at 100°.

Analysis. — Calc. for $Ag_2C_4H_2O_4$: Ag, 65.42. Found: 65.44.

The compound deflagrated when heated during combustion (leaving metallic silver) and the carbon and hydrogen results are considered unreliable.

Silver Fumarate.—This compound has not been described. It was prepared in the same way as was the maleate, and behaved similarly. Its silver content was 64.90 per cent.

SOLUBILITIES.

A number of the salts were tested for solubility in water. Samples were placed in 60 cc. bottles with distilled water and securely stoppered. They were then held in a thermostat at the required temperature for 24 hours, 25 cc. portions of the clear solutions were withdrawn in a weighing bottle by means of a pipet with cotton filter, weighed, transferred to a platinum dish, evaporated to dryness and heated to constant weight at 100°. With the acid salts, the amount of solute was determined by titration. The sampling of the solutions saturated at 60° and 100° was done entirely under the surface of the water in the thermostat with an apparatus described by Pawlewski.[22].

The solubility results are given in Table I.

SUMMARY.

The data in the literature regarding the salts of maleic, fumaric and *i*-malic acids have been reviewed and the water of crystallization of a number of these salts determined. In some cases the work agrees with that of past observers, but in others new numbers are apparently justified. Some 11 salts, not previously described, were prepared and the water of crystallization determined in certain cases definitely.

The solubilities in water of 22 salts were determined and tabulated. In general, fumarates are less soluble than the corresponding maleates.

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[19] *Henderson and Barr*, *J. Chem. Soc.*, 1896, LXIX., 1451. *Henderson and Prentice*, *ibid.*, 1894, LXVII., 1030.

[20] *Pelouze*, *Ann.*, 1834, XI., 263.

[21] *Lloydl*, *Ann.*, 1878, CXCII., 80. *Kekulé*, *Ann.*, 1864, CXXX., 1. *Pasteur*, *chim.*, 1852 [3] XXX., 49. *Werigo* and *Tanatar*, *Ann.*, 1874, CLXXIV., 367.

[22] *Pawlewski*, *Ber.*, 1899, XXXII., 1040.

TABLE I.

SOLUBILITIES OF FUMARATES, MALEATES AND MALATES.

Compound.	Formula.	Solubilities in g. per 100 g. of water. 25°	30°	40°	60°	100°
Cadmium fumarate ..	$CdC_4H_2O_4$	...	0.09	...	...	...
Cadmium maleate	$CdC_4H_2O_4.2H_2O$	...	0.66	...	...	...
Calcium acid fumarat	$Ca(C_4H_4O_4)_2.2H_2O$	...	5.19	...	...	...
Calcium fumarate	$CaC_4H_2O_4.3H_2O$	...	1.56	...	...	...
Calcium acid maleate	$Ca(C_4H_3O_4)_2.5H_2O$	21.13	...	41.89	94.78	...
Calcium maleate	$CaC_4H_2O_4.H_2O$	2.49	...	2.88	...	...
Cobalt fumarate	$CoC_4H_2O_4.4H_2O$	...	0.88	...	...	...
Copper fumarate	$CuC_4H_2O_4.2H_2O$	...	0.02	...	...	...
Copper maleate	$CuC_4H_2O_4.H_2O$	...	0.12	...	...	...
Lead fumarate	$PbC_1H_2O_4$	...	0.025	...	...	...
Lead *i*-malate	$PbC_4H_4O_5.{}^1/_2H_2O$	...	0.21	...	...	...
Lead maleate	$PbC_4H_2O_4$	...	0.052	...	...	...
Manganous fumarate	$MnC_4H_2O_4$	...	0.14	...	...	...
Nickel fumarate	$NiC_4H_2O_4.5H_2O$	...	0.36	...	...	...
Silver fumarate	$AgC_4H_2O_4$	...	0.013	...	...	...
Silver maleate	$AgC_4H_2O_4$	...	0.12	...	...	...
Sodium acid fumarate	$NaC_4H_3O_4$	6.87	...	10.74	18.15	30.2
Sodium fumarate	$Na_2C_4H_2O_4$	22.83	...	...	...	...
Sodium acid maleate	$NaC_4H_3O_4.3H_2O$	6.73	...	12.81	31.3	288.0
Sodium maleate	$Na_2C_4H_2O_4.{}^1/_2H_2O$	96.06	...	...	...	...
Strontium fumarate	$SrC_4H_2O_4$	...	0:29	...	...	...
Zinc fumarate	$ZnC_4H_2O_4.5H_2O$	...	1.96	...	...	...

STREATFEILD MEMORIAL LECTURE.

The Streatfeild Memorial Lecture was delivered by Mr. E. M. Hawkins, F.I.C., at the Finsbury Technical College, on October 25. He dealt with various aspects of Analytical Chemistry.

After reference to the value of the training which he and his former fellow students had received at the college under Meldola, Streatfeild and Castell Evans, the lecturer emphasised the importance of a knowledge of Physics, Mathematics and Physical Chemistry to the present-day Analyst and Consultant. He advised the students to qualify as soon as possible after the college course for membership of the Institute of Chemistry, and emphasised the importance of the Finsbury course in primarily training men for the practice of Chemistry.

First among the qualifications required in the analyst the lecturer placed accuracy and reliability, to which should be added the ability to decide to what degree of accuracy his results attained. He should also have a due sense of his responsibility in carrying out his work, especially when extensive repetition gave to it an appearance of drudgery.

Secondly, there was the need for rapidity to be associated with accuracy, as few students realised the speed of manipulation which would be required of them when they obtained a post after leaving college.

Thirdly, it was of great importance that the students should cultivate the gift of expressing his results suitably in a report, for much good experimental work was marred by the inability of the chemist to write up his results in such a way that the bearing of the work could be properly appreciated by those who read the report. It was necessary that the chemist should not be easily moved from an opinion formed after careful consideration of results which were obtained by honest work and patient investigation.

In conclusion, the lecturer stated that of the three classes of men practising chemistry—works' chemists, public analysts, consultants—the first class would greatly outnumber the public analysts when trade revived, whilst consulting chemists would be men of wide experience and high attainments who would be called upon by manufacturers to solve their problems, and should be highly remunerated for such

PROCEEDINGS AND NOTICES OF SOCIETIES.

PHYSICAL SOCIETY OF LONDON.

A meeting was held on Friday, October 26, at the Imperial College of Science, South Kensington, S.W.

The following papers were read:—

The Fine Structure of Some Sodium Salts of the Fatty Acids in Soap Curds, by S. H. PIPER, D.S.O., B.Sc., and E. N. GRINDLEY, B.Sc.

X-Ray Analysis of Solid Solutions, by E. A. OWEN, M.A., D.Sc., and G. D. PRESTON, B.A.

Cohesion, by DR. H. CHATLEY.

Proceedings of the meeting held on June 22, Alexander Russell, M.A., D.Sc., in the chair:—

The Excitation and Ionization Potentials of Gases and Vapours, by PROF. F. HORTON, M.A., D.Sc., F.R.S., Holloway College, University of London.

The study of ionization potentials dates back to the discovery of the phenomenon of the ionization of gases by collision, but the theoretical importance of a knowledge of the least difference of potential through which an electron must fall in order to acquire sufficient energy to ionize a gaseous atom or molecule on collision with it has greatly increased since the propounding by Bohr of his theory of atomic structure. Bohr's theory predicted the possibility of an atom being excited to emit radiation by the impact of an electron having energy in excess of a definite minimum amount—an amount corresponding to an "excitation" potential less than that required for ionization. This prediction has been verified experimentally for a large number of different atoms, and the study of excitation and ionization potentials has yielded strong support for the fundamental assumptions o the theory.

The experimental methods of investigation may be divided into two classes:—

(1) Those depending on the detection of the loss of energy by the colliding electron.

(2) Those depending on the detection of the radiation or ionization resulting from the collisions.

An account was given of several investigations by each method, and the results obtained were briefly summarised. The ... of helium was referred to in greater detail. Bohr's view of the structure of the helium atom was described, and the way i[n] which it leads to the prediction of a meta[-] stable state of this atom was indicated. Ex[-] perimental results in support of this vie[w] were quoted.

Finally, the prediction of the absorptio[n] by a normal atom of radiation emitted b[y] another similar atom during the transitio[n] from an excited to the normal condition wa[s] explained, and the experiments by means o[f] which the prediction has been verified we[re] described.

THE SOCIETY OF PUBLIC ANALYST[S] AND OTHER ANALYTICAL CHEMIST[S]

The next meeting of the Society will [be] held on Wednesday, November 7, at t[he] Chemical Society's Rooms, Burlingt[on] House, Piccadilly, W., at 8 p.m. The f[ol-] lowing papers will be read:—

A Quantitative Study of the Limitati[on] of the Reaction between Ammonia and [So-] dium, by DINSHAW RATTONJI NANJI [and] WILLIAM SIMPSON SHAW.

The Gold-Beaters' Skin Test for Tanni[ns], by PHYLLIS H. PRICE, B.Sc.

Determination of Nitrogen in Coal, by [...] DONOVAN, M.Sc.

The Estimation of Lead in Water [and] Urine, by J. C. THRESH, D.Sc., M[.D.,] F.I.C.

THE INSTITUTION OF ELECTRIC[AL] ENGINEERS.

ORDINARY MEETING, NOVEMBER 1.

Industrial Research, with Special Re[fer-] ence to Electrical Engineering Deve[lop-] ment, by W. WILSON, B.E., M.Sc., M[EM-] BER.

During the past 40 years, radical cha[nges] in manufacturing conditions have rend[ered] industrial research essential for the at[tain-] ment of reasonable efficiency and progr[ess].

Industrial research is divisible into [two] orders, the more general and the more [par-] ticular, both being necessary for the pr[oduc-] tion of a new article. The second is us[ually] termed "Development," and is the s[pecial] subject of this paper.

While British men of science and a[pplied] science have been pre-eminent for g[eneral] research, little attention has been p[aid]

development. Hence few inventions have, within recent years, been brought to their conclusion in this country, as compared with the great amount of original scientific work which has been successfully accomplished.

The reasons for this were analysed, and the cause is traced to lack of the co-operation necessitated by modern manufacture. This want is filled by development departments.

The various functions of the latter were dealt with. Their outcome is the removal of all non-standard work and technical troubles from the shops and drawing offices, and the provision of original and matured designs of new and improved articles for manufacture.

The negligible value of ordinary sources of novel suggestions was discussed, and the qualifications of a development man are deduced. The question of staffing the department, and the educational qualifications which the staff should possess, are then treated.

Practical matters, including buildings and equipment, procedure in development, the recording and filing of results and data, and the indexing of literature and information were discussed.

A short summary was given of the principal industrial research organisations in Great Britain, with a brief discussion on co-ordination.

THE SOCIETY OF GLASS TECHNOLOGY.

The first meeting of the Society of Glass Technology for the session 1923-24 was held in Sheffield on October 17, the President, Prof. W. E. S. Turner, D.Sc., in the chair.

"Frank Wood" Medals were presented to Mr. A. H. Sheen, B.Sc.Tech., and Mr. F. Winks, B.Sc.Tech., by Sir W. H. Hadow, C.B.E., M.A., D.Mus. The design of the medals was the work of Mr. Percy Metcalfe, a former pupil of Prof. W. Rothenstein, Professor of Civic Art in the University of Sheffield. Prof. Rothenstein pointed out that it had been the custom during the last century, when new medals were struck, to go to France for them, but whenever an Englishman got his chance, he showed that he could do this work much better than anyone else. People would not realise that to have faith in their own contemporaries was one of the first duties of citizenship.

A paper, illustrated by lantern slides, entitled, *The Effect of Titania on the Properties of Glass*, by A. R. SHEEN, B.Sc.TECH., and PROF. W. E. S. TURNER, D.Sc., was given by Mr. Sheen. Much has recently been shown in the production of heat resisting glass. Manufacturers, especially of scientific glassware, were realising the necessity of making a glass which had a high thermal endurance, and which was also capable of resisting the attack of substances with which the glass came into contact, whether solid, liquid, or gaseous. Modern heat resisting glasses contained a high percentage of silica and also boric oxide in considerable amount, *e.g.*, the well known glass, Pyrex (which owed its high thermal endurance to its exceptionally low coefficient of expansion, 0.0000032) contained approximately 80 per cent. silica and 12 per cent. boric oxide. In the case of silica the difficulty was to obtain a sufficiently high melting temperature. Glasses containing boric oxide were very readily melted; but here the objection was the effect of the oxide on the durability of the glass. Recent research in the Department of Glass Technology of Sheffield University has shown that as the B_2O_3 content of a glass was increased, the durability towards water and acid increased to a maximum, and then, as the B_2O_3 content was further increased, the durability fell off rapidly. Boric oxide containing glasses (and of course glasses with high silica content), on account of their acidic nature, were readily attacked by alkalis. What information there was concerning the use of titania in the production of glass seemed to point to the fact that titania glasses were heat resisting, but no experimental data were given. It was with this consideration specially in mind that this piece of work was undertaken.

At the outset, preliminary tests were made to find out what mixture of silica, titania and soda would give glasses at the highest temperature obtained in glass melting practice, *e.g.*, temperature of 1,400° to 1,450° C. It was found impossible to obtain a glass from silica and titania alone at this temperature. Batches were then calculated out on the basis of the glass formula:

$6\ SiO_2\ x\ Na_2O\ yTiO_2$, where $x + y = 2$,

and it was found that the first six members of the series gave glasses quite readily, *i.e.*, glasses of the approximate molecular compositions:-

(1) 6 SiO_2 1.9Na_2O; 0.1TiO_2.
(2) 6 SiO_2. 1.8 Na_2O, 0.2 TiO_2.
etc. etc. etc.
(6) 6 SiO_2, 1.4 Na_2O, 0.6 TiO_2.

which the soda was gradually replaced titania. Above 1.8 mol. TiO_2, *i.e.*, 13 r cent. TiO_2, it was found increasingly fficult to melt the glass, and higher temratures were required.

It was found that if these glasses were elted under reducing conditions, their lour varied from light amber to dark own. Therefore, part of the soda content as added as nitrate, and the melting eration was carried out in crucibles with ell-fitting lids. By this means, colourless asses were obtained.

There were indications during these meltg operations that titania glasses were heat sisting. It was found in many cases that ie glass could be removed straight from ie furnace and allowed to cool down in the pen air without splintering or cracking of ie mass of glass occurring.

After considering the analyses of these ix glasses, the first question dealt with was he durability of the titania glasses towards vater. It was found on comparing with he corresponding lime and magnesia glasses hat the titania glasses were less attacked han the lime glasses, especially in the arlier members of the series. The duraillities of the titania glasses were found to e practically the same as those of the coresponding magnesia glasses.

The annealing temperatures were found o be rather less than those of the corresonding lime and magnesia glasses.

Next, the important question of thermal expansion was dealt with. It was originally intended to determine this optically by the Fizeau-Pulfrich method, but after discussion it was eventually decided to repeat the melts on a large scale to draw tubing and determine the expansion by the ordinary dilatometer method. The thermal expansions of these titania glasses (only the first four glasses of the series were tested) were only slightly less than those of the corresponding lime glasses. Therefore, if titania glasses are heat resisting, it is certainly not due to their having a low expansion, as is the case with Pyrex glass, for example, but the cause must be sought in some other factor, such as tensile strength or elasticity.

[illegible]ese glasses possessed good working [illegible] their viscosity increasing as [illegible] of [illegible]laced soda. Throughout all the [illegible] in connection with this work any evidence of devitrification occurring. This bore out the statement of previous workers that titania hindered devitrification.

Mr. A. Cousen, B.Sc., A.R.C.S., then gave a paper entitled *The Estimation of Selenium in Glass.* Illustrating his remarks with experiments, Mr. Cousen said that during researches on the use of selenium as a decolourising agent, it was found desirable to obtain a process for the estimation of selenium in the glasses obtained. The amount of selenium actually added to the batch was, in general, of an order sufficient to give only 1 part of the element per 42,000 parts of glass, or 0.0024 per cent., if no less occurred. Since, however, selenium was volatile at the temperature of the furnace (the boiling point at 1 atmosphere pressure is 680°), values considerably less than the above were likely to be found. The only chemical method for estimating selenium in glass so far published was that of Fränkel, and described by Witt (Sprechsaal, 1914), and this was not quite comparable, since it dealt with proportions of selenium at least ten times as great as those it was desired to estimate.

The following modification of the above process was found to give results of fair accuracy. Twenty grams of finely powdered glass were dissolved slowly in hydrofluoric acid, and after standing in the cold, with the exception of selenium, the products of decomposition were dissolved by pouring into excess of boiling water. The selenium itself was filtered off on a filter pulp pad in a Gooch crucible. From the pad the selenium was removed by treating with a dilute chlorine solution (about one three-hundredth normal). To the filtered solution was added 1 cc. of 5 per cent. gum arabic and 5 cc. of half per cent. phenyl hydrazine hydrochloride—the whole being made up to 50 cc. Colloidal selenium was obtained, a yellow colour slowly developing, which was after half an hour matched against a standard solution of sodium selenite similarly treated. The method on testing with synthetic mixtures, gave results well within 0.0002 per cent. of the actual values, and a commercial glass, for which selenium had been used sufficient to give theoretically 0.0025 per cent., was found to contain actually only 0.0006 per cent. of the element.

To the discussion that followed there contributed the President, Messrs. W. J. Rees, J. H. Davidson, and J. R. Clarke. Mr. Cousen replied.

During the forenoon a party of members of the Society had an opportunity of visiting the River Don Works, Sheffield, of Messrs. Vickers, Ltd.

The next meeting will be held in the lecture room of the Coal, Gas and Fuel Industrial Department, the University, Leeds, on the afternoon of Wednesday, November 21.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

There will be a wireless section meeting in the lecture theatre of the Institution, on Wednesday, November 7. An inaugural address will be delivered by the Chairman, Mr. E. H. Shaughnessy, O.B.E.

INSTITUTE OF METALS.

Lecture on American Metallurgy.

Dr. W. Rosenhain, F.R.S., is to lecture before the Institute of Metals, London Local Section, on *Some Impressions of American Non-Ferrous Metallurgy*, on Thursday, November 8.

THE INSTITUTE OF PHYSICS.

At the last meeting of the Board the following Corporate Members were elected:—*Fellows*: G. R. Bolsover, J. A. Jones, C. H. Lander, T. Takamine, A. Warren; *Associates*: K. R. Brain, A. L. Gregson, J. S. Grew, J. A. Hughes, E. O. Hercus, T. J. Lonsdale, R. D. Thompson, J F. Wood.

GENERAL NOTES.

NETHERLANDS.

Tenders Invited for Various Goods.

Mr. R. V. Laming, O.B.E., the Commercial Secretary at The Hague, informs the Department of Overseas Trade that the Colonial Establishment, Westerdoksdijk 2, Amsterdam, is calling for tenders for various goods, tenders to reach the Director of the Colonial Establishment (through the Dutch representatives of United Kingdom firms) by 1 p.m. on October 31, 1923.

The goods required include white writing paper, cardboard, packing, copying and miscellaneous paper, leather hat bands, hard haberdashery for uniforms, nails, shoe rivets and hooks and eyelets, ironmongery, zinc sheets, earthenware pipes, street cobbles, fireproof stone, bookbinders' glue, sealing wax, certain chemicals and oils, and soap and soap powder.

The tenders are called for under the usual general conditions, but the Department of Overseas Trade has available for inspection, by interested British firms, copies of the specifications (in Dutch), containing special requirements and dates of delivery. These may be seen on application to the Department at 35, Old Queen Street, S.W.1 (Room 84).

It will be noted that tenders must be submitted through local representatives. The Department will be pleased to place U.K. firms desirous of tendering and not represented in Holland, in touch with firms having branches in Holland who may be willing to act on their behalf in this matter. (Reference: 20890/F.W./G.P.).

UNIFORMS AND GENERAL STORES FOR EGYPTIAN POSTAL ADMINISTRATION.

Mr. E. Homan Mulock, H.M. Commercial Agent for Egypt, reports that the Postal Administration at Alexandria is inviting tenders, to be presented in Alexandria by noon on November 15, 1923, for the supply of uniforms and general stores (including mail-bags, boots, calcium carbide, candles, furniture, hardware, lamps, steel stamps, etc.).

Further particulars may be obtained by interested United Kingdom firms on application to the Department of Overseas Trade, where a copy of the specifications, conditions, and form of tender, etc., is available for inspection up to October 31. After that date these documents will be forwarded on loan, in order of application, to firms in the provinces, who may be unable to arrange for their inspection by a London representative.

The Ministry of Agriculture and Fisheries has re-issued Leaflet No. 80, on *The Use of Artificial Manures*. It is pointed out that there are two main classes of manures:—

(1) Natural (organic)—the direct product of animals or plants, such as farmyard manure, seaweed, green manure, fish guano, &c.

(2) Artificial (inorganic)—this term is used quite correctly of such manures as *superphosphate*, nitrate of lime and others which are produced by processes of manufacture; it is also used, not quite correctly, of mineral manures such as mineral phosphate, potash salts and nitrate of soda, which are, strictly speaking, natural.

There are three forms of food which plants mainly require from the soil, nitrogen, potash and phosphates. Artificial manures, as a rule, supply only one of these forms. Each class—nitrogenous, potassic and phosphatic—comprises several kinds of manures which differ in their action. Thus in the nitrogen class, nitrate of soda is quicker in its action than sulphate of ammonia, and in the phosphate class superphosphate is quicker than raw phosphate. Or one kind may be more suitable to a certain crop than another, as, in the potash class, sulphate of potash is better than kainit for potatoes, and in the phosphate class basic slag is usually better for grassland.

Guidance is given as to the average quantities required by different crops. Three points require to be noted:

1.—If a plant is stinted in one of its requirements, even though other requirements are abundantly provided, the result will be little better than if it had been equally stinted of all.

2.—It is equally wasteful to use too much as too little manure. The right amounts will lie somewhere in the neighbourhood of what is here given; the actually correct amounts can only be learned by experience and by trial.

3.—Costs, both one's own and those given in records of trials, must be studied. The dressing which produces the highest yield is not always the most economical.

Of hardly less importance than the selection of manures is their distribution. Whatever amount of manure is employed, care should be taken to spread it equally over the soil. Artificial manures are easier to spread evenly when they are fine and free from lumps. It may be necessary to pass the material through a quarter-inch riddle, breaking all the lumps that fail to go through. Some manures change into hard lumps if stored for some months. This is one reason why it is seldom desirable to store manures for a long period. If this has to be done, the addition of a small proportion of peat-litter dust or sawdust will help to keep them from caking. One often sees artificial manure being sown containing lumps as large as peas, and sometimes as large as walnuts. Not only does the presence of lumps prevent much of the crop getting its air share of the dressing, but the spots on which the lumps fall are actually poisoned, so that the plants are weakened or killed outright.

Where possible, manures, especially the slower acting manures, should be thoroughly mixed with the soil. For instance, where artificials are being applied to a corn crop, they should be applied at seed time, so as to get the benefit of the subsequent harrowing.

NOTICES OF BOOKS.

Practical Physical Chemistry, by ALEXANDER FINDLAY, M.A., D.Sc. Pp. XVI. + 298. Fourth Edition. London: Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 1923. 7s. 6d. net.

The first edition of Prof. Findlay's indispensable *Practical Physical Chemistry* appeared in 1906, and the third in 1914. Since the latter date the demand for the book has been met by the printing of new impressions.

Nearly a decade has elapsed since the subject matter has been revised, and hence, in the latest edition, he includes many alterations and extensive additions, yet the general character of the book as a student's laboratory companion remains unaltered.

New matter has been introduced, dealing with Cottrell's Ebullioscopic Method for determining Molecular Weights, and accounts of the Abbe Refractometer and Hilger's (constant deviation) Wave-length Spectrometer are also included.

Another important addition is a chapter containing a very suitable set of experiments illustrating some of the more striking properties of the colloidal state of matter.

It is now generally recognised that practical physical chemistry must form a part of a general chemistry curriculum, and the appearance of the present new edition should enable Prof. Findlay's volume to retain its popularity among both students and lecturers.

Kelly's Directory of the Chemical Industries. Pp. XXXI. + 903. 1923. Kelly's Directories, Ltd., 186, Strand, W.C.2. 30s.

Information is given concerning chemical manufacturers, manufacturing chemists, wholesale druggists, drysalters, chemists and drug stores (wholesale and retail). Full lists of the trades comprised will be found in this book.

The sections of Kelly's Directory of the Chemical Industries, 1923, include:—An alphabetical arrangement of the names in the towns and villages under each county, with the populations; a general classification of trades for London and its suburbs, *i.e.*, classified lists of profession and trades with the names arranged alphabetically of those engaged therein; a similar classification for the rest of England, Scotland and Wales; the names for the principal towns of Ireland, arranged under towns and trades; and the names of the Channel Islands and the Isle of Man arranged under towns.

Another feature is the list of proprietary brands and articles which gives the makers' name and address after the name of the articles.

It is very apparent that many alterations have been necessary, and it need hardly be pointed out that out-of-date directories are often the cause of much inconvenience and irritation. This applies to those for the chemical industries as well as others.

Report of the Oxygen Research Committee. Pp. VII. + 177; with 43 text figs. and 6 plates. 8s. 6d. net. By post 8s. 9d. Published by H.M. Stationery Office for the Dept. of Scientific and Industrial Research.

This report describes certain aspects of the work of the Oxygen Research Committee since its appointment in 1919. It deals chiefly with the technical difficulties which have hitherto restricted the commercial utilisation of liquid oxygen and liquid air, and describes in particular recent improvements in the methods of handling the liquefied gases on a practical commercial scale. The work of the Committee has been carried out principally in the Heriot Watt College, Edinburgh, and the Air Ministry Oxygen Laboratory.

The subject matter of the report is arranged under the following headings:—

Part I.—*The Storage of Liquefied Gases*: The vacuum vessel; the physics of the vacuum vessel; experimental analysis of heat entry; adsorbents and adsorption.

Part II.—*The Manufacture of Metal Vacuum Vessels for Liquefied Gases*: Defects of containers and vaporisers; improvements in the design of vaporiser receptacles; the assembly of vacuum vessels; the testing of vacuum vessels; the problem of evacuation; evacuating plant.

Part III.—*Vacuum Vessels in Use*: Glass vacuum flasks; the transference of liquefied gases; some results of the periodic testing of vaporisers; decay of vacua in metal flasks.

Part IV.—*The Transport of Liquefied Gases and Compressed Gases*: Protection and support of containers in transit; losses during transport; railway regulations for the transport of liquid air; the transport of compressed oxygen.

Appendix.—Physical Data.

Index.

Copies may be obtained through any bookseller, or direct from H.M. Stationery Office.

BOOKS RECEIVED.

Van Nostrand's Chemical Annual, by JOHN C. OLSEN, A.M., PH.D. Pp. XXII. + 900. Fifth issue, 1923. Messrs. Constable & Co., Ltd., 10-12, Orange Street, W.C.2. 21s. net.

Smith's General Chemistry for Colleges, by JAMES KENDALL. Pp. XIII. + 747. 1923. Messrs. Bell, York House, Portugal Street, W.C.2. 18s. 6d. net.

Recent Developments in Atomic Theory, by LEO GRAETZ, Professor of Physics in the University of Munich. Pp. XI. + 174. 1923. Messrs. Methuen & Co., Ltd., 36, Essex Street, W.C.2. 9s. net.

Chemical Engineering Catalog, by THE CHEMICAL CATALOG COMPANY, INC. Pp. 1,050. Eighth Annual Edition, 1923. The Chemical Catalog Company, Inc., 19, East 24th Street, New York, U.S.A.

The Manufacture of Nitric Acid and Nitrates, by ALLIN COTTRELL, M.Sc., F.I.C., M.I.CHEM.E. Pp. XV. + 554. 1923. Messrs. Gurney & Jackson, 33, Paternoster Row, E.C.4. 36s. net.

Elementary Chemical Calculations, by MARTIN MEYER, PH.D., College of the City of New York. Pp. VI. + 131. 1923. Oxford Book Company, 175, Fifth Avenue, New York, U.S.A.

PUBLICATIONS RECEIVED.

Bulletins issued by the U.S. Department of the Interior, Bureau of Mines:—

The Electrothermic Metallurgy of Zinc, by B. M. O'HARA. Pp. VI. + 106.

Timbering of Metal Mines, by E. A. HOLBROOK, RICHARD V. AGETON, and HARRY E. TUFFT. Pp. VII. + 72.

Water-Gas Tar Emulsions, by W. W. ODELL. Pp. IV. + 51.

Leaching Nonsulphide Copper Ores with Sulphur Dioxide, by CHARLES E. VAN BARNEVELD and EDMUND S. LEAVER. Pp. V. + 91.

New Patents.

This list is specially compiled for *The Chemical News*, by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

25111—British Cellulose & Chemical Manufacturing Co., Ltd.—Treatment of cellulose derivatives. Oct. 9.

25326—Crundall, S. F. W.—Production of titanium compounds. Oct. 11.

25274—Thorn, I.—Process of hardening products of condensation from phenols and aldehydes. Oct. 10.

25478—Hoffman la Roche & Co., Akt-Ges. F.—Manufacture of emulsions of bismuth salts. Oct. 12.

Specifications Published this Week.

[illegible]-Ges Fur Kohlentechnik.—Process and apparatus for separating ammonia and ben[illegible] hydrocarbons from coal distillation

187592—Howard, H.—Process for the production of hydrogen sulphide.

192703—Soc. d'Etudes Chimiques pour l'Industrie. Process for the manufacture of urea from cyanamide.

Abstract Published this Week.

202743—Hypodermic injections.—Kato, J., of 33, Ekandocho, Kamikyo-ky, Kyoto, Japan.

Hypodermic injections; colloidal sols.—A remedy to be injected into hæmorrhoids consists of a colloidal suspension of metallic magnesium in a harmless and chemically inert liquid such as glycerine, olive oil, or liquid paraffin. The colloidal suspension is prepared by finely powdering the magnesium, suspending it in the glycerine, &c., and passing an electric current of 2 amps at 40 volts between platinum electrodes for a period of two hours with continuous stirring and cooling. The preparation is stored in an atmosphere of hydrogen or nitrogen.

Lignone sulphonic acids; pulp, preparation of.—Wood and like lignified materials are resolved by treatment at 100-110° C. with a strong aqueous solution of sulphurous acid which is originally substantially free from sulphuric acid. Preferably the process is carried out in a digester lined with acid-resisting cement, and the materials under treatment are rapidly agitated. In an example, wood prepared as for the bisulphite process is treated with six times its weight of a seven per cent. solution of sulphurous acid purified from sulphuric acid. The mass is heated with open steam for six hours; then steam at a temperature of 105-110° C. is employed for a further ten hours to complete the resolution. The liquor, containing the lignone derivatives may be evaporated to dryness, preferably under reduced pressure, or prepared in concentrated form for transport. These derivatives are stated to be different from those contained in sulphite-cellulose liquor.

Sulphurous acid for use in the process is rendered free from sulphuric acid by treatment with barium sulphite or, according to one Provisional Specification, with barium acetate or bisulphite.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

JOURNALS FOR SALE.

JOURNAL OF THE CHEMICAL SOCIETY, 1915, 1920, complete with Indexes, £1 each year. Journal of Industrial & Engineering Chemistry, 1919, £1. *Chemical News*, 1921, 1922, 15s. each year. All unbound, but in excellent condition.—H.E., c/o *The Chemical News*, 97, Shoe Lane, London, E.C.4.

THE. CHEMICAL NEWS,

VOL. CXXVII. No. 3317.

BRITAIN HER OWN CHEMIST.

Progress of a Vital Industry.

A sum of £100,000 is to be spent on the Chemical Section of the British Empire Exhibition at Wembley next year. It is to occupy 40,000 square feet in the Palace of Industry, and it will be built in such a way as to form a self-contained hall within the Palace. It is intended to present to the public a complete picture of the present state of the British Chemical Industry. No important firm in the industry will be unrepresented, and their exhibits will number over a hundred.

In an interview last week, Mr. W. J. U. Woolcock, C.B.E., General Manager of the British Association of Chemical Manufacturers, said that the chemical hall, in which the exhibits will be grouped, would be the most comprehensive exhibition of the products of British science and industry ever brought together. It would certainly be the biggest thing British chemical industry has yet attempted, and there will be every hope of impressing the Empire both with their present position and their prospects.

They were not going to be content with an impressive spectacle of past achievements; they desired to illustrate what is behind the processes of production. They hope, also, to show that by reason of British invention and research there are guarantees that the industry will never be left behind again.

A group of the best scientific minds in this country are co-operating with the Association in illustrating the advances made in the last 20 years in every branch of pure chemical science. The importance of the chemical industry in the daily life of any nation is vital, and they are going to illustrate it. There is the sulphuric acid industry, which is such an index of national prosperity that Disraeli once said: "The measure of a country's prosperity can be gauged by the amount of sulphuric acid it is producing per head of population." The alkali industry is one of the most important of the chemical industries, too, and its *development* is one of the romances of Britain.

Then there are all those industries which have arisen out of the distribution of coal, the production of coal-tar products, and the preparation of the thousand and one substances of the dyestuff and fine chemical industries. The discovery of the first artificial colouring matter was made in England; its development was, as one might *expect, left to the Germans. In* 1913, 80 per cent. of the dyestuffs used in this country were obtained from Germany and Switzerland; to-day we produce 80 per cent. of what we require, and import only 20 per cent.

The discoveries of British chemists in the *class of chemicals called* antiseptics have been instrumental in saving thousands of valuable lives, and such discoveries are only the beginning. The extraordinary progress made in recent years in British laboratories has helped to make the disease-ridden lands within and without the Empire safe for the white man. Without these remedies, some of which are quite new to science and have been elaborated during and since the war, British colonization and trade in the tropics and sub-tropics would be seriously handicapped.

Chemistry is the "open Sesame" of modern industry. The constant scientific control of the manufacture of foodstuffs, of the means of locomotion, of the supply of gas and water, is essential in modern life. The establishment of a complete British chemical industry is a great achievement. The Association considers it vital that the Chemical Section at the British Empire Exhibition should adequately represent the growing importance of the industry. That is why the Committee is taking such pains to ensure that the display they are arranging shall be fully represented.

We certainly think that whatever damage the war may have done to the industry, good support and representation in the matter will again, put it on a substantial and even more progressive basis. J.M.

—*(By courtesy of the British Empire Exhibition, 1924, Inc.)*

ARE THE NATURAL GROUPINGS OF THE ELEMENTS AND THE SPECTRAL LINES OF HYDROGEN RELATED?

Part III.

By F. H. Loring.

In continuation of the above subject—see The Chemical News, 1923, Vol. CXXVII., pp. 273-275—the question arises as to whether the argument presented can be strengthened by taking into consideration certain phenomena that may be in some unknown way related thereto.

Since the atom is now believed to be a planetary system in which the electron represents the planet and the nucleus of the atom the sun, a consideration of our solar system in connection with these studies is of interest. It is possible that a planetary system such as our solar system is not an ideal one to compare with the so-called planetary system of hydrogen. Sir O. Lodge has practically raised this question, but so far as the writer is aware, no direct or indirect relations have been found comparable in exactitude with Bode's Law. It will be seen from the accompanying table that the groups α, β, γ, δ, ϵ afford direct values which, so far as they extend, agree about as well with certain planetary distances as do Bode's figures, especially when the comparison is made in the manner indicated in the table referred to.

Semi-Major Axis of Orbit.

	Bode's Law.	Earth=10.	Diffs.	Millions of Miles ÷ 10.	Groups.	Diffs.
Mercury	0 + 4 = 4	3.87	+0.13	3.6	—	—
Venus	3 + 4 = 7	7.23	-0.23	6.72	7	+0.28
Earth	6 + 4 = 10	10.00	0.00	9.29	9	-0.29
Mars	12 + 4 = 16	15.23	+0.77	14.16	13	-1.16
Asteroids	24 + 4 = 28	27*		25†	21	
Jupiter	48 + 4 = 52	52.02	-0.02	48.33	48	-0.33
Saturn	96 + 4 = 100	95.39	+4.61	88.62	—	—
Uranus	192 + 4 = 196	191.90	+4.1	178.28	—	—
Neptune	384 + 4 = 388	300.70	+88	279.35	—	—

* This is a mean value, the extremes being below 25.5 to above 28.5.

† This is a mean value, the extremes being below 23.7 to above 26.5.

Above planetary data taken from Kaye and Laby's "Tables of Phys. and Chem. Constants."

Notes.

In the column giving the distances from the sun in millions of miles divided by 10, it should be noted that the figures are mean ones.

With regard to the asteroids, or minor planets as they are often termed, there may have been a planet of moderate size and of small mass, between Mars and Jupiter, which was reduced to comparatively small fragments by disruption. There are over 800 minor planets, *the largest having a diameter of about 400* miles.

It has been shown mathematically that if such a catastrophe had occurred, the orbits of the small bodies should at some time in their paths pass through the place where the disruption took place in space, but this coincidence is apparently not the case. From other considerations, such as a series of catastrophies, the calculation may require revision, so that "the whole problem of the asteroids is one that should ment against the rules made evident in the above table.

It is to be noted that the smallest mean distance for the minor planet Medusa is 198,134,000 miles; so that in a remote sense the group forms a kind of mass band (their planes do not coincide), one edge of which corresponds fairly closely with the value 21.

The following quoted paragraph from the first of a series of articles on the atom by Sir O. Lodge, in *Beama*, of July, August, September, October, 1923 (continued), is of interest, but the agreement between Bode's law and Bohr's law of orbital radii in respect of the hydrogen atom is not as close as are the α, β, γ, δ, ϵ group values in the comparison given above in the table. Lodge says:—"The electric case is simpler than the planetary, for the planets differ in mass as well as in distance, whereas the electrons are all alike and differ only in distance from the centre. Every orbit will have its characteristic moment of momentum, and if we could say that this moment of momen

innermost orbit, was 2 for the next, 3 for the next, and so on, it would be delightfully simple. 'In other words, if the moment of momentum, or what is practically the same thing, the rate of sweeping areas, is not only constant for each orbit, but proceeds by equal steps or simple multiples from one orbit to the next, how much simpler the law of succession would he than the at present unknown law of succession of the planets—the discovery of which was attempted long ago by the astronomer Bode. Well, strange to say, *this simple law does appear to hold rather accurately for the atomic orbits.* This was discovered not by Bode, but by Bohr. Calling the unit moment of momentum a *lot* (which is a convenient name employed by auctioneers for an indivisible group which you can take or leave as a whole), the moments of momenta characteristic of successive orbits have to be 1 lot, 2 lots, 3 lots, etc., as the orbits increase in radii; and the result is that the radii of successive orbits proceed as the squares of the natural numbers, provided the law of attraction is as the inverse square of the distance—as for electrical attraction we know it is. Because, according to Kepler's Third Law, r^3 varies as T^2 (cube of distance proportional to square of periodic time), or, what is the same thing, the product rv^2 is the same for all the orbits. Hence vr proceeds according to the natural numbers, 1, 2, 3, 4, etc., in arithmetical progression, the radii r must proceed according to the squares of these numbers, 1, 4, 9, 16, etc. This is algebraically necessary. These are the successive Bohr orbits, which seem to be the only stable and permanent ones; no other orbits seem possible. A particle [electron] may drop from one orbit to the next, but it cannot rest or revolve in any intermediate position. The full reason of this has still to be discovered, but the fact is evidenced by many considerations."

An interesting view in connection with Bode's law is discussed by Miss M. A. Blagg in a paper in the *Royal Astronomical Society Monthly Notes*, 1913, vol. 73, p. 414.

Referring to the diagram shown on page 258, this is reproduced to the scale of about ½ millimeter per unit, but the values were re-proportioned to bring them into the range of the plotting selected. In the case of the wave lengths, the original unit was increased by dividing them by 30. The group values were raised by multiplying them by 3.

The calculation, quite apart from the plotting, is obviously a simple one, viz.:—Wave length (λ) in Augstrom units minus 3540, divided by 61.5 = the group values; that is to say, $(\lambda - 3540)/61.5 = \alpha, \beta, \gamma,$ &c.

The figures given on page 274 of Part II. as being representative of the fine lines of hydrogen in respect of the $H\alpha$ line resolution, were taken from Foote and Mohler's book, "The Origin of Spectra," 1922; but the noughts before the decimal places should be cancelled.

Corrections. — On page 258, right-hand column, fifth line down, "first" should read "prior." On page 274, left-hand column, fourth line from bottom, "since" should read "moreover." On same page, right-hand column, second line from top, "and by" should read "which." Further down, paragraph beginning with "Apart," first line, "these" should read "the." The large table of figures, etc., should be labelled at the top "SCHEME." On page 275, right-hand column, second line from top, "when considering" should read "as compared with."

RECENT RESEARCHES IN ORGANIC CHEMISTRY.

By R. F. HUNTER, F.C.S.

(*Continued from page* 263.)

In July, 1921, a short paper by Fairbourne and Toms on a Monosodium glyceroxide, in which preparations of a Monosodium Glyceroxide, $CH_2(OH)CH(OH)CH_2ONa$, Glycerol 2: 4 Dinitro phenyl ether, $C_6H_3(NO_2)_2\ O\ CH_2(OH)\ CH_2\ O\ H$ 2 : 4 Dinitro phenyl allyl ether, 2 : 4 Dinitro Hexyl Dibromopropyl ether, $C_6H_3(NO_2)_2\ O\ CH_2\ CH\ Br\ CH_2Br$, were described.

The third part of Burton and Trinner's investigations on influence of nitro groups on reactivity of substituents in benzene nucleus, partial reduction of dinitro toluenes by $SnCl_2$ and HCl, in which the action of ammonia on 3 : 4 dinitro oxylene was also studied, appeared. The fourth part, communicated at the same time, dealt with the condensation of ethyl 3 and 5 nitro 2 chlorobenzoates with hydrazines, had Kenner and Witheim as its authors, and the experimental part gave an account of the action of hydrazine hydrate on ethyl 2 chloro 5 nitro benzoate and derivatives; 4 nitro 2 carbethoxy phenyl hydrazine,

$NO_2\,C_6H_5(CO_2Et)$ N H N H_2, benzaldehyde 4 nitro 2 carbethoxy *phenyl hydrazone*, 5 nitro 3 keto 1 : 3 dehydroindazole,

$$NO_2C_6H_3 < \begin{matrix} NH \\ CO \end{matrix} > NH$$

5 amino 3 keto 1 : 3 dehydroindazole were examined.

The *action of phenylhydrazine on ethyl* 2 chloro 5 nitro benzoate was studied, and compounds 5 nitro 3 keto 2 phenyl 1 : 3 dehydroindazole, 3 chloro 5 nitro indazole, 3 chloro 5 nitro 2 phenylindazole, 7 nitro 3 keto 1 : 3 dehydroindazole prepared.

The action of the same reagent on ethyl 2 chloro 3 nitro benzoate was examined with the preparation o 2 nitro 6 carbethoxy hydrazobenzene,

$NO_2C_6H_3(CO_2Et)$ N H N H C_6H_5,

and of 7 nitro 3 keto 2 phenyl 1 : 3 dehydroindazole.

In *July, Morgan and Webster's paper on* the isomeric diazonium salts of dehydrothio toluidine appeared. They found these *to exist in syn and anti modifications and* prepared.

1 Phenyl 5 methyl benzothiazole 4′ azo naphthol syn and anti 1 phenyl diazohydrochlorides, Potassium syn and anti 1 phenyl 5 methyl benzothazine,

4′ diazo oxides,

Sodium syn and anti phenyl 5 methyl benzothiazole,

4′ diazosulphonates,

Syn and anti 1 phenyl 5 methyl benzothiazole,

4′ diazo cyanides,

4′ Cyano 1 phenyl 5 methyl benzothiazole,

Syn 1 phenyl 5 methyl benzothiazole 4′ *diazo salts, such as acid diazo chromate*, nitro prusside, ferricyanide, diazo carbonate, diazo chlorate, and diazo ortho borate.

A paper was published by Mason on β Hydroxy β 3 : 4 methylenedioxy phenyl ethylamine and derivatives at this time.

β Hydroxy β 3 : 4 methylenedioxy *phenyl ethylamine and its salts and derivatives* were prepared.

Part II. of Perkin and Titley's work on *Epi-camphor appeared also at this time*, and among the substances prepared and examined were:

Hydroxy methylene 1 epicamphor,

Benzoyloxy methylene epicamphor,

Hydroxy methylene epicamphor semi carbazone,

seriesanilinomethylene epicamphor,

may reqohthyl aminomethylene epicamphor,

problem of

Aminomethylene epicamphor,

l and d epicampholenonitrite,

l and d epicampholenic acid,

Dihydroepicampholenolactone, and

dl campholenic acid.

Published at the same time was the first part of King's work on derivatives of sulphur in commercial salvarsan and the experimental part contains an account of reduction of 3 nitro 4 hydroxy phenylarsenic acid with sodium hyposulphite, isolation of 3 amino 4 hydroxy 5 sulphinophenylarsenic acid and 3 : 3′ Diamino 4 : 4′ dihydroxy 5 : 5′ disulphino arsenobenzene.

Oxidation of 3 amino 4 hydroxy 5 sulphino phenylarsenic acid to 3 amino 4 hydroxy 5 sulphophenylarsenic acid 3 : 3′ diamino 4 : 4′ dihydroxy 5 : 5′ disulphinoarsenobenzene.

3 : 3′ Diamino 4 : 4′ dihydroxy 5 sulphino arsinobenzene hydrochloride.

3 : 3′ Diamino 4 : 4′ dehydroxy 5 sulpho 5′ sulphino arsenobenzene.

The action of magnesium phenyl haloids on diphenyl chloracetyl chloride, and the constitution of triphenylvinylalcohol was *studied by McKenzie and Boyle, who* examined the constitution of the alcohol, the actions of Mg Ph Br and Mg Ph I on diphenylchloracetyl chloride, and *that of* Ph Mg Br on triphenylvinyl alcohol.

Some new tri cyclic bases by Moore and *Doubleday appeared at the same time* among which mention may be made of the following:—1 : 4 endo methylene 6 methy tetra hydro quinoxaline and 1 : 4 end ethylene 6 methyl tetra hydro quinoxalin and 1 : 4 endo tri methylene 6 meth tetra hydroquinoxaline.

Three other papers also appeared b Atack which dealt with the structural isc merism of oximes, criticism of the Hantzsc Werner hypothesis, and a new theory c constitution of isomeric oximes. Th author summarised his results in the fo lowing way:—

(1) The *Hantzsch Werner hypothesis* the stereo isomerism of oximes is criticise in view of the fact that it fails to explai *characteristic reactions of the so-called* sy and anti oximes, their mode of interconve sion, etc., and further, fails to interpr Beckmann reaction as applied to the be zildioximes.

(2) A new structural theory of isomerisi of oximes is advanced, which explains satis factorily the number of isomerides know to exist, the differences in the salt formin

properties of the oxime groups present in isomeric oximes and formation of O and N ethers.

The paper on the structural isomerism of oximes, Part II., was summarised thus:—

(1) A fourth isomeric benzildioxime, M P 217°, has been prepared, differentiated by colour and behaviour of nickel compound, and by other reactions from the three known benziloximes.

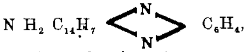
(2) The Hantzsch Werner hypothesis only admits of the existence of 3 isomeric benzildioximes, whereas the structural theory admits of six.

Hepworth and Clapham's paper on the action of Grignard reagents on organic sulphur compounds contained an account of the action of magnesium phenyl, ethyl bromide, and of magnesium benzyl chloride on benzene sulphonyl chloride. The action of magnesium methyl iodide on ethyl mercaptan and preparation of thio esters from magnesium ethyl thiol bromide.

The action on ethyl thiobenzoate of Mg Et Pr and Mg Ph Pr, and on di isoamyl sulphoxide, diphenyl sulphoxide phenyl benzyl sulphoxide and trimethylene trisulphoxide.

Action of Mg Me I on diphenylsulphone, phenyl benzylsulphone, trimethylenetrisulphone and ethyl phenylsulphoneacetate.

Watson and Dult's paper, from Bengal, on dyes derived from phenanthraquinone contained preparation of azine derivatives of phenanthrene, 2 amino phenanthraphenazine,



4 Aminophenanthraphenazine,
2 : 7 Diaminophenanthraphenazine,
4 : 5 Diaminophenanthraphenazine,
2 : 7 Diaminodihydrophenanthraphenazine,
2 : 7 Dihydroxy dihydro phenanthraphenazine,
2 : 7 : 11 Triaminophenanthraphenazine,
2 : 7 Diamino 15 hydroxy phenanthranaphthazine 13 sulphonic acid,
2 : 7 Dinitro 15 hydroxy phenanthranaphthazine 13 sulphonic acid,
2 : 7 Dinitro 11 : 4′ dimethyl flavinduline chloride,
Phenanthraquinone 2 : 7 bis (2′) azo 7′ amino hydroxynaphthalene 3′ *sulphonic* acid,
$C_{14}H_6 O_2 [N_2 C_{10} H_4 (NH_2) (OH) S O_3 H]_2$,
Phenanthraquinone 4 : 5 bis (2′) azo 7′ amino 1′ hydroxynaphthalene 3′ sulphonic acid,
11 Aminophen anthra phenazine 2 : 1 bis (2′) azo 7′ amine 1′ hydroxy naphthalene 3′ sulphonic acid,

$$N H_2 C_{20} H_9N_2 [N_2C_{10}H_4 (NH_2 (OH) S O_3 H]_2,$$

and

2 : 7 Diaminophenanthraquinone diphenyl hydrazone p p′ disulphonic acid.

The second part of Naik's paper on dithio ketones and ethers was communicated in June to the T.C.S., and contained in the experimental portion references to the preparation of dithio mesoxo p toluidide, the o compound, dithio mesoxo α and β naphthylamine,

Dithio mesoxomone p toluidide,
Dithio mesoxomonophenylamide,
Ethyl dithiomesoxo p tolylamide,
Ethyl dithiomesoxo o tolylamide,
Methyl malono p toluidide disulphide,
Methyl malono o toluidide disulphide,
Methyl malono o toluidide disulphide,
Methyl malono dimethylamide disulphide.

The interaction of ethyl so-diocyanoacetate, ethyl sodiomalonate, ethyl cyanoacetate, and of ethyl malonate and S_2Cl_2, and also of 1 : 1 dimethyl cyclo hexane 3 : 5 dione and sulphur monochloride, 3 : 5 : 3′ : 5′ tetraketo 4 : 4′ bis dithio 1 : 1: 1′ : 1′ tetra methyl di cyclo hexyl 2 : 2′ disulphide was carried out.

Interaction of cyclohexane spiro cyclohexane 3 : 5 dione and S_2Cl_2. 1 : 1′ di cyclo hexanespiro 3 : 5 3′ : 5′ tetra keto 4 : 4′ bis dithiodi cyclo hexyline 2 : 2′ : 6 : 6′ bis disulphide.

Interaction of cyclopentanespiro cyclohexane, 3 : 5 dione and S_2Cl_2, cyclopentane spiro 3 : 5 diketo 4 dithio cyclohexane gave α γ disulphidoacetonide carboxydianilide.

Ethyl γ phenylcarbamyl α γ bis disulphido aceteacetate α γ disulphidoacetone dicarboxydi p toluidide.

Two papers by Hepworth are worthy of note. The first, on the action of Grignard reagent on tervalent organic iodo compounds, containing an account of the action of magnesium powder on iodobenzene dichloride and p iodo toluene dichloride. The second paper was on the accelerated formation of magnesium, alkyl and aryl haloids.

Dudley's paper, entitled Amino acylcholine esters, deserves mention, and contains an account of glycyclocholine platino and auri chlorides, $N Me_3 Cl C_2H_4O CO CH_2 NH_2 HCl Pt Cl_4 H_2O$, and $N Me_3 Cl C_2H_4O CO CH_2 N H_2 H Cl_2 Au Cl_3$.

A paper on the action of sodium on phenylacetate was published by Perkin and described:

2 Methyl benzo γ pyrone, dehydroacetic *acid*,

1 Hydroxy 3 methylxanthone, its methyl ester, and 2 4 nitro 1 hydroxy 3 methylxanthone.

Mills, Harris and Lambourne's research on the Doebner-Miller quinaldine synthesis contained, among other things, the synthesis of 6 Ethyl quinaldine.

Coffey and Ward's paper on allyl compounds deserves mention, as does the former's paper on linoleic and hexabromo-*stearic acids, published at the same time.* At this time a further piece of Goddard's work appeared, and contained an account of thallium dimethyl and diethyl o, m and p nitro phenoxides, and also of dinitro and trinitro phenoxides.

Simonsen and Rems' synthesis of 1 : 6 di hydroxy 2 methyl anthraquinone appeared about this time, in the experimental part of which reference is made to 3 nitro 2 methoxy p toluic acid and 3 nitro 2 methoxy *p toluidine.*

Two papers which appeared at this time and deserving mention, are those on the cupri tartarate, by Packer and Wark, and the labile nature of halogen atoms in substituted nitro methanes, by Macbeth and Pratt, and the colorations produced by substituted nitro forms by Macbeth and Graham. Two papers also appeared by McBain and his co-workers on the hydration of the fibres of soap curd.

Two papers were also published by Perkin and Robinson and Perkin and Scarborough. The first on "Studies of Configuration of αα' Dibromodibasic Acids, Pt. I., The Dibromoadipic Acids and Synthesis and Resolution of trans cyclo pentane 1 : 2 : 3 tri carboxylic acid." The second on "Resolution of dl trans cyclo pentane 1 : 3 dicarboxylic acid," appeared in the T.C.S. for July.

Coffey's second paper on oxidation of drying oils appeared in the same issue, and con*tained α and β Linolenic acids and linolic* acid.

The second part of King's work on Salvarsan contained the study of the Monosulphonation of p nitro phenol, the diamination of 6 nitro 4 amino phenol o sulphonic acid, 6 nitro phenol o sulphonic acid, and an account of 6 amino phenol o sulphonic acid and its nitration and the reduction of isomeric nitro amino compounds to the same 6 diamino phenol o sulphonic acid.

[illegible]'s paper on Phenolcoumarin and Resorcinolcoumarin deserves mention, published at the same time as Cohen and Froelicher's research on the nitro and amino derivatives of *m* hydroxy benzoic acid. This paper contains an account of 4 amino m hydroxy benzoic acid and its derivatives.

Hamer's paper on isomeric iso cyanines contains details of the preparations o[f] quinaldine and quinoline derivatives an[d] methiodides, such as nitro, amino, quinal[i]dines, cinnamaylamine, quinaldine, an[d] *quinolines.*

Short's method for preparation of ac[y] phenyl hydrazines appeared at this tim[e] with Burrow's and Turner's paper on addi[-]tive compounds from arsines which de[-]scribes compounds such as Ph Me_2 As, P I and Ph Me_2 As, As I_3.

They also published an account of the a[l]kylation of nitroprussic acid.

Kenner and Witham's paper on the i[n]fluence of steric factors on intra molecul[ar] *condensation was communicated in August* 1921, to the Chemical Society, and contain *the preparation of 7 chloro* 1 hydrindon[e] and 5 chloro 1 hydrindone.

Henstock's paper on 9 : 10 dehydrophe[n]anthrene is worthy of note.

The third part of McLeod and Robinson['s] researches on pseudo bases, dialkyl amin[o] methyl alkyl ethers, and sulphides, was al[so] published at this time, and is of some i[n]terest. An interesting and characterist[ic] property of pseudo basic carbinols is the fo[r]mation of ethers by simple treatment wit[h] alcohols.

Further work on terpenes, by Henders[on] *and Marsh, has appeared in the form of t[he]* study of action of hypochlorous acid on p[i]nene and the preparation of pinene dichlo[ro]hydrins, $C_{10}H_{16}O_2Cl_2$, and of chlorohydrin $C_{10}H_{17}O_2Cl$.

Two papers by Heilbron and Buck we[re] published together, on the reactivity [of] double conjugated unsaturated ketones, t[he] first on 4' dimethylamino 2 hydroxy [di]styryl ketone, and contains a description [of] the compound and various analogous and k[e]*tonic bodies, such as* OH C_6H_4CH : *CH* C[...] CH : CH C_6H_4N $Me_2C_6H_4$ (N Me_2) CHO.

The additive *compounds* of 4' dimeth[yl] amino 2 hydroxy distyryl ketone, 4' [di]methylamino 2 methoxy distyryl keto[ne] were also examined.

The second paper deals with the action [of] hydroxylamine semicarbazide and phenylh[y]drazine on 4' dimethylamino 2 hydroxy d[is]tyryl ketone and its methyl ester, in the e[x]perimental part of which we find a descri[p]tion of the compound, O H C_6H_4HCH : C

CO CH : CH C_6H_4N Me_2N H_2OH, and other analogous bodies.

Papers by Morgan and Challenor and Morgan and Burgess, on the ortho chloro dinitro toluenes, and referring to bases from 2 chloro 4 : 5 dinitro toluene and non-aromatic diazonium salts, have appeared, in which the condensation of 6 chloro 3 : 4 tolylene diamine with diketones and ortho quinones was studied, and the interaction of 6 chloro 3 : 4 tolylenediamine and formaldehyde (a) in neutral solution, (b) in acid solution.

The diazo reaction in the iso-oxazole series was also investigated, and compounds such as 3 : 5 dimethyl iso oxazole 4 azo acetyl acetone examined.

The paper by Fairbourne on ortho dimethyl anthraquinone and derivatives is of interest. Among the compounds prepared were 2 : 3 and 1 : 2 dimethylanthraquinone and 1 : 2 dicarboxylic acid.

A long research on Harmine and Harmaline, the synthesis of norharman, by Kermack, Perkin and Robinson, has also appeared. It may be pointed out that the fused pyridine-pyrolle nucleus type of organic compound has received little, if any, attention. Harmine is methyl methoxy 4 carboline. The compounds norharmine and harman are obtained by elimination of the methyl and methoxy groups from harmine. The relation between harman and tryptophan was discussed in the *Journal* of the Chemical Society, 1919. The experimental work included the following preparations: Harman from tryptophan, harmolic acid, norharmol, norharman, 3 carboxyindole 3 acetic acid, etc. It also included the condensation of indole 2 carboxylic chloride with alanine ester and sodium derivative of ethyl acetoacelate, and a description of 6 methoxy indole, 11 methoxy 5 keto 4 : 5 dehydroindole diazine, and the synthesis of norharman and the study of 6 methoxy 3 methyl indole 2 carboxylic acid and of 6 methoxy 3 methyl indole.

The paper by Simonson on the essential oil from andropogon waranqusa and the constitution of piperitone is worthy of note.

A very interesting paper by Moir has appeared on the calculation of colour in cyclic substances, and a method of calculating the colour of dicyclic substances and monocyclic substances is detailed in the papers.

In October, two more papers were communicated by Morgan and Glover and Morgan and Vining. The first on the familiar subject of ortho chlorodinitro toluenes dealt with 2 chloro 3 : 4 dinitro toluene. The second paper was on dinaphtha 1:7:1′:7 diquinone, and described the oxidation o dihydroxy naphthalenes with metallic per oxides. Compounds such as dinaphth 1:7:1′:7′ diquinonetetra 2:4 dinitro phenyl hydrazone, the reduction of dinaphth 1:7:1′:7′ diquinone, by H. I. Henry, and Paget's paper on chenopodium oil also appeared at this time.

Fargher and Perkin's paper on *m* opianic acid is of interest, and contains references to homoveratrole, ketonic derivatives, the oxidation of 4:5 dimethoxy o tolyl methyl ketone, 4:5 dimethoxy phthalonic acid, the action of aniline on 4:5 dimethoxy phthalonic acid, *m* opianic acid (4:5 dimethoxy o aldehydro benzoic acid) and its derivatives.

In September, Read and Andrews' paper on studies of halogenohydrins and related derivatives of cinnamic acid, Part I., was communicated. Among the questions studied were: The addition of H Cl O and of H BrO to cinnamic acid and to methyl coumaric acid.

The application of Hofmann's reaction to substituted phthalimides, by Moore, Marrack and Froud, appeared at the same time.

Smiles and Stewarts' paper on m dithiobenzoic acid appeared at this time.

Copisarow's paper on Freidel Crafts Reaction, migration of alkyl groups in benzene nucleus, deserves a mention. Smiles and McClelland's research on the derivatives of 3 oxy-(1)-thio naphthena is of interest, and contains in the experimental part details of the interaction of ethyl acetoacetate and 2 thiolbenzoic acid, and the isolation of condensation products and derivatives.

Shimomura and Cohen's new method for resolution of asymmetric compounds was published at the same time, and contains a description of the preparations of l menthyl d l phenyl chloroacetate, C_6H_5 CH Cl·CO_2·$C_{10}H_{19}$, l menthyl dl phenylbromoacetate, C_6H_5 CH Br $CO_2C_{10}H_{19}$, l menthyl dl bromophenylpropionate, C_6H_5 CH_2 CH Br·$CO_2C_{10}H_{19}$.

The action of SO Cl_2 on l menthyl dl mandelate and that of P Cl_5 on bromopropiono d bornylamide and other analogous substituted amido-bodies was also studied.

In Perkin and Plant's research on derivatives of tetra hydrocarbazole, the reduction products of carbazole are of interest because of their relations to strychnine.

Tetra hydrocarbazole and 9 methyl tetra hydro carbazole were oxidised to 9 methyl carbazole.

Bennet and Whincop's paper on deriva-

tives of monothio ethylene glycol appeared in September, and contained descriptions of a number of new and complex aliphatic sulphur compounds, such as ββ′ di p nitro benzoyloxydiethyl disulphide, ethylene bis β hydroxy ethyl sulphide, ethylene bis β chlorethyl sulphide, sulphido bis β hydroxydiethyl sulphide, and 2:4 dinitro phenyl β *hydroxy ethyl sulphide*, $C_6H_3(NO_2)_2$ S · CH_2 CH_2 OH.

Crompton and Triffitt's short paper on Dichloroacetates and Chlorobromoacetates from a β Dichlorovinyl ethyl ether is worthy of note.

In October, Morgan and Hickenbottom's paper on Studies in n Butyl Series, Part I., Aryl and n Propyl ketones, appeared, and the extensive experimental part contained much that was important in connection with these comparatively simple bodies.

Grant and Pyman's research on the Nitro- and Amino-derivatives of 4 Phenylglyoxaline appeared at the same time, in which 2 Thiol 4 phenylglyoxaline and 4 phenylglyoxaline were described. The nitration of 4 phenylglyoxaline led to the isolation of 4o *and 4p nitro phenylglyoxalines. The nitration* of 4p nitro phenylglyoxaline gave 5 nitro 4 p nitro phenyl glyoxaline.

The benzoylation of 4 phenylglyoxaline and its nitro derivatives was also accomplished.

Towards the end of August, Ray published a paper on synthesis in the Thianthren series. The method of condensation employed was to dissolve the substance in dry CS_2 in a flask filled with the acid of a reflux condenser and dropping funnel, and containing S_2Cl_2. The catalyst (aluminium foil) was inserted previous to addition of S_2Cl_2. The following were studied: Dichloro thianthren, dichlorodimethylthianthren, diacetyl amino thianthren, dimethoxy thianthren, diacetyl thianthren, dibenzyl thianthren, thianthrendicarboxylic acid.

Singh and Lal's *studies on Aryl derivatives* of bis iminocamphor are worthy of mention. They prepared oo′ di tolylenebis imino camphor, oo′ dimethoxy diphenylene bis imino camphor, pp′ diphenylene bis imino camphor, and pp′ bis iminocamphor diphenylamine.

Duff's paper on cis phthalate, cis homo phthalate; and other ethylene diamine cobaltic salts is of note. Among the compounds studied were: cis phthalatediethylene diamine cobaltic salts, *cis o sulphobenzoate* diethylene diamine cobaltic salts, cis ...benzene 3:4 disulphonate diethylene ... diethylene diamine cobaltic salts, trans dichlorodiethylene diamine cobaltic hydrogen benzyl sulphoacetate, and trans dichloro diethylenediamine cobaltic hydrogen sulphobenzoate.

Rowe and Levin's researches in the dihydronophthalene series, the ar dihydro α naphthols and derivatives, were published about this time.

In December, 1921, there appeared Silberad's researches on Sulphuryl Chloride, Part I., Influence of *catalysts. Among the* catalysts employed were: iodine, thionyl chloride, sulphur, sulphur chloride, ferric chloride, Al Cl_3, and mixed catalysts.

Cohen and Crabtree's paper on Structure and Colour of Azine Scarlets appeared at this time, and was summarised by themselves in this way:—

1.—The formation of quaternary metho chloride has only slight effect on the tint o the parent hydrochloride.

2.—Transition from a simple amino grou through a mono-alkylated to a dialkylate amino group is accompanied by gradation in tint from pure scarlet, through scarlet ma*genta to pure magenta.*

3. Transference of both amino groups to same nucleus produces a fundamenta change in colour.

4.—Replacement of benzene by naphthalene or tetra hydroquinoline nucleus pr duces little change on tint.

5.—Absence of radicles in nucleus e hances the blueness of shade.

Among their work were preparations of 3 amino 7 dimethylamino 2 methyl phenazine metho chloride; 3 amino 7 dimethylamino 2:8 dimethylphenazine metho chlorid 5 aminonaphtha phenazine 7 metho chlo ide 9 amino; 5 dimethylamino 10 meth *naphthaphenazine hydrochloride*; 9 amino dimethylamino 10 methyl naphtha phen zine metho chloride; 3 amino 7 dimeth amino phenazine metho chloride; 3:7 tet methyl *diaminophenazine*; 3 amino methyl N methyl tetra hydro quinolin phenazine metho chloride; 3 amino methylamino 2 methyl phenazine met chloride; 3 amino 7 methylamino 2:8 methyl phenazine metho chloride; 3 ami 7 benzylamino 2:8 dimethyl phenaz *metho chloride*; 3:7 diamina 2:8 dimeth phenazine metho chloride; 3:7 diamino methyl phenazine metho chloride; and 5 diamino 10 methyl naphtha phenazi *metho chloride.*

Fairbourne and Toms' new synthesis osazines appeared in December, and co tained in the experimental part 2:4 dinit

phenyl hydroxy ethyl ether, and 6 amino 2:3 dihydro 1:4 benzisoxazine.

Dult, Whitehead and Wormall's paper on the action of diazo salts on aromatic sulphon amides, Part I., appeared at the same time, and contained a description of the action of benzenediazonium chloride on p toluene-sulphoamide.

The action of o toluenediazonium chloride on the same, and of m toluene diazonium chloride on the same.

The action of p toluenediazonium chloride and p chlorobenzenediazonium chloride on p toluene sulphoamide.

The action of benzenediazonium chloride, o toluenediazonium chloride, m and p toluenediazonium chlorides on benzenesulphoamide, and lastly of p chlorobenzenediazonium chloride on benzenesulphoamide.

Mills' and Nodder's paper on optically active forms of keto dilactone of benzophenone 2:4:2:4′ tetracarboxylic acid deserves mention.

The last paper published in 1921 was by Ruth King, on the production of picric acid from sulphonic acids of phenol. The work contained the examination of 6 nitro phenol 2:4 disulphonic acid and nitrolysis of sulpho groups in the ortho and para positions.

DR. MULLER'S X-RAY SPECTROGRAPH.

To meet the requirements of various classes of users, including crystallographers, chemists, metallurgists, radiologists, and others, Dr. Müller has designed, and Messrs. Adam Hilger, Ltd., 75a, Camden Road, London, N.W.1, have placed on the market at the price of £44, an extremely compact form of X-ray Spectrograph. While of sufficient accuracy, the instrument is made of simple design and at such cost that it can be put into the hands of advanced students who are capable of profiting by experience of this important class of work.

The instrument consists of a support carrying a rotating table for the crystal mount, and passing through the latter a bar of triangular section upon which slide carriers for slit and plate-holders respectively. This support is mounted on a box containing a spring-motor, to the shaft of which is attached a cam. A lever, which can be clamped at any orientation to the axis of the crystal table, is kept in contact with the cam by a spring, and is thus oscillated through a certain angle as the cam rotates. With the cam usually supplied an angle of oscillation of about 12° is obtained.

The crystal mount consists of a vertical plate with lead screen, to which the crystal can be attached with soft adhesive wax and which is provided with tilting adjustment about a horizontal axis. The mount can be traversed in a slide across the rotating table so as to bring the face of the crystal up to the axis of rotation. The edge of the table is divided in degrees to facilitate the setting relative to the lever in order to register lines upon each side of the normal to the photographic plate.

The slit consists of two brass blocks 26 mms. long, which can be clamped at a known distance apart, one of a number of "feeler" gauges supplied being inserted between the jaws before clamping.

The plate-holder, which is attached to its slide by two milled head screws, is designed to take plates 12 cms. x 1.9 cm., which can be cut from standard size plates (¼-plate size). It is provided with a black paper screen, so that the instrument may be used in daylight without risk of fogging the plate, and no special sheath for the plate is necessary.

In order to measure the distance between the centre of rotation and the surface of the photographic plate, a steel rule divided in millimetres is supplied, which will pass through the slit mount. The centre of rotation of the table is determined by a fiducial mark upon a pin which can be inserted in the table when the crystal mount is removed. This is quickly done by unscrewing the retaining screw of the spring top and sliding the mount out of its groove.

The instrument is mounted on three levelling screws, the heads of which, as well as those of other adjusting screws, are made of vulcanite to minimise risk of shock in case the instrument is charged by induction from the tube and transformer, etc. A lead screen is also mounted upon the instrument to prevent fogging of the plate by stray X-radiation.

The instrument is available for work with a single crystal by the Bragg method. By a simple interchange of parts which can be effected in about one minute, it becomes suitable for the investigation of powders by the Debye method. The slit jaws, crystal mount and plate-holder are removed, and the carriers moved up to support a circular camera, 6 cms. in diameter, which carries a

photographic film. The camera is so disposed that a powder-holder can be inserted in the centre of the rotating table and advantage taken of the oscillating movement for this work also. In place of the slit is mounted a brass block pierced with an aperture of 1 mm. in diameter. The end of this block fits into an aperture of the camera and points directly to the powder-holder in the centre.

The instrument is also available for taking photographs by Hull's powder method, a small spring, which can be quickly attached to the slit, being supplied. Thus the three standard methods now in use are available in the one instrument.

The motor is such as to give about 40 oscillations per hour to the crystal, and to run nearly 8 hours without rewinding.

GENERAL NOTES.

MINERAL PRODUCTION OF CANADA, 1922.

The High Commissioner for Canada in London has received from the Dominion Bureau of Statistics at Ottawa the following finally revised statistics on the production of Non-Metallic Minerals in Canada during 1922.

With the exception of arsenic there were no outstanding differences between the production of 1922 and the previous year of the commodities listed in the table below as miscellaneous non-metallic minerals.

The production of arsenic in 1922 was 2,576 tons, an increase of 1,085 tons, or 42 per cent., when compared with 1921. Large quantities of this commodity are being used in the United States for insecticides which are found to be particularly effective in combating the boll weevil, an insect which has caused great damage in the cotton districts during recent years.

		1922.	
		Quantity.	Value in Dols.
Actinolite	Tons	50	575
Arsenic (white) produced from Canadian ores	,,	2,576	321,037
Barytes	,,	289	9,537
Chromite	,,	767	11,503
Feldspar	,,	27,727	248,402
Fluorspar	,,	4,503	102,138
Graphite	,,	597	31,353
Grindstones	,,	1,005	43,742
Magnesite	,,	2,849	76,294
Magnesium sulphate	,,	1,021	24,017
Manganese	,,	73	2,044
Mica	,,	3,349	152,263
Mineral water	Gals.	221,443	14,220
Natro-Alunite	Tons	50	2,500
Iron oxides	,,	7,285	110,608
Peat	,,	3,000	14,500
Phosphate	,,	190	1,796
Pyrites	,,	18,143	74,303
Quartz	,,	109,947	208,598
Sodium carbonate	,,	202	3,027
Sodium sulphate	,,	504	11,980
Talc	,,	13,195	188,458
Tripolite	,,	219	5,781
Total		....	1,658,676

THE DESTRUCTION OF PLATINUM CRUCIBLES.

The destruction of platinum crucibles, which is always attributed to a chemical change in the platinum, can be prevented (according to a publication by Heraens), if unnecessarily high temperatures in heating the crucible are avoided. The combinations of platinum with carbon, silicon, boron, phosphoric acid, etc., arise through reduction of the salt being heated at relatively high temperatures. The ease with which hydrogen and hydro-carbons pass through glowing platinum makes such a reduction easy. The use of acetylene for heating platinum is, for this reason, especially dangerous. Melted alkalis, alkaline carbonates, in the presence of sulphur, or potassium cyanide, strongly attack platinum at high temperatures.

Easily fusible metals and easily reducible metallic oxides cannot be treated in platinum, and the same is true of all substances which give off chlorine, bromine, iodine, sulphur or phosphorus.—*Chemiker-Zeitung, July* 24, 1923.

THE WORLD'S AGRICULTURAL RESULTS.

On the basis of statistical data and other information published in the October International Report of Agricultural and Commercial Statistics of the International Institute of Agriculture, Rome, the results of the Northern Hemisphere harvests are now ascertainable, together with estimates for some of the more important crops in the Southern Hemisphere.

The aggregates for the Northern Hemisphere (exclusive of Russia) in 1923 surpass those of 1922 by 7.6 million metric tons of wheat (10 per cent.), by 3.2 million of rye (15 per cent.), 2.8 million of barley (13 per cent.), 6.4 million of oats (14 per cent.). These increases mainly arise from plentiful yields in Europe and North Africa, where a favourable season was experienced, in sharp contrast with the drawbacks suffered last year by the grain crops. In North America and in Asiatic countries the totals are very similar to last year's, which showed good results.

A preliminary estimate, quite provisional, from the Southern Hemisphere is available from Argentina, where the wheat yield is forecasted at 6.8 million tons, which is the highest figure on record for that country, and shows an increase of 1.6 million metric tons (31 per cent.) over last year. Again, in Australia, the area under wheat is nearly similar to that in 1922, and good yields are anticipated, as conditions are favourable during growth.

It may, therefore, be regarded as certain that the aggregate production of these four grain crops is considerably larger than it was last year. This is not all, for the recent crops of wheat and oats, with barley also in minor degree, are actually larger than those immediately before the war. Comparisons are available from the recently published International Yearbook of Agricultural Statistics issued by the Institute. Apart from Russia, the harvests of 1923, inclusive of all those countries which have supplied data, exceed the averages furnished in the Yearbook for 1909 to 1913 by 12.4 million metric tons of wheat (16 per cent.), 3.3 million of oats (7 per cent.), and 0.7 million metric tons of barley (3 per cent.). Rye alone falls short by 1.4 million (5 per cent.).

Taking the several continents separately the European and North African crops are nearly equal to those of the pre-war period, though none of the four attains a parity. The ascertained increases as compared with pre-war figures are therefore consequent on extensions in the other continents, particularly in America.

Available data for the Northern Hemisphere maize crops are not quite so complete, as data are not yet to hand from Rumania, Jugoslavia and a few other countries. An increased yield of 5.2 million metric tons (7 per cent.) may be already indicated, however, owing almost entirely to the plentiful crop in the United States.

As regards linseed, special reference is due to the exceptionally large yield in Argentina, where the preliminary estimates are for 1.9 million metric tons, or 0.8 million more than last year's yield, which was in itself a very good one. Taking into account the fine harvests of linseed in other countries whence data are to hand, the yield already tabulated amounts to 3.2 million metric tons, and indicates an increase of 5[illegible] per cent. over last year's yield.

The aggregate yield of sugar-beet in the countries which have already supplied data—which represents rather over 50 per cent of the world's total yield—comes out decidedly larger than that corresponding to 1922: 21.1 million metric tons as compared with 19.2 million, or 10 per cent

more. *It would seem that the sugar content too is likely to be higher.*

Potatoes, on the other hand, are expected to yield a much poorer aggregate than last year. The countries which have furnished data, representing slightly over one-half of the world's production (apart from Russia), report a yield of 65.5 million metric tons, as compared with 80.1 last year, showing a decrease of 18 pr cent. When considering these results it should, however, be borne in mind that 1922 was a year of exceptional plenty for potatoes, the then yield being far above the average.

AUSTRALIA'S OVERSEAS TRADE IN JULY.

The Officer in Charge for His Majesty's Senior Trade Commissioner in Australia has forwarded to the Department of Overseas Trade a brief resumé of the returns of the Commonwealth's overseas trade for the month of July.

These returns show, in comparison with the corresponding month last year, an increase in imports of nearly £2,000,000, while exports show a decrease of over £2,500,000. The value of imports exceeded exports by £6,500,000.

Imports of boots and shoes showed an increase as compared with the corresponding period in 1922, while cotton and linen, silk and woollen piece goods showed a decrease. Imports of petrol (£453,828) more than doubled, and chassis for motors £679,659) increased by £266,439.

Exports of wool were over £2,200,000 in value below those of July, 1922. Shipments of gold exceeded those in the same period by £134,877. Exports of Australian products from the States were:—

	£
New South Wales	1,699,053
Victoria	989,732
Queensland	1,198,221
South Australia	687.443
Western Australia	784,696
Tasmania	22.178

The Northern Territory imported £939 worth of merchandise; there were no ex-

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, NOVEMBER 1.

Papers read:—

E. G. T. LIDDELL and SIR CHARLES SHERRINGTON, PRES. R.S.: *A Comparison between certain Features of the Spinal Flexor Reflex and of the Decerebrate Extensor Reflex respectively.*

J. BARCROFT, F.R.S., and H. BARCROFT: *The Blood Pigment of Arenicola.*

The blood pigment of Arenicola Marina differs from the hæmoglobin of human blood in certain respects.

(1) The α band of the oxy-hæmoglobin is situated 18 Angstrom units nearer the violet, and

(2) The α band of the CO-hæmoglobin is situated 11 A.U. nearer the violet than the corresponding human band.

(3) The dissociation curves show a greater affinity for both oxygen and carbon monoxide than those of human blood under similar conditions.

(4) The affinity for CO is about 70 times that for oxygen, as compared with 250 in man and 140 in the mouse. The possibility of a relationship between the position of the bands and the affinity of the pigment for gas is discussed.

(5) The main unloading of oxygen from the pigment of Arenicola would appear to be between 1 and 3 mm. pressure.

(6) The mean oxygen capacity of the hæmoglobin per gram of Arenicola is about 0.01—0.013 cc.

A comparison between the oxygen capacity of the pigment and the total oxygen consumption of the worm reveals the fact that the pigment holds sufficient oxygen to supply the animal for 1-2 hours, and probably acts as a reserve to tide it over the period at low-water when its hole is closed.

T. DEIGHTON: *The Basal Metabolism of a Growing Pig.* Communicated by Prof. T. B. Wood, F.R.S.

Various alterations in the calorimeter described in *J. Agric. Sci.*, vol. 11 (1921), are mentioned, and certain modifications of technique described.

The basal metabolism of a pig has been measured at various ages from 75 days up

wards, and it has been shown that in the pig, as in human beings, the metabolism per unit area is greater in mid-youth than at any other time of life.

Experiments are adduced to show that the metabolism after the ingestion of food reaches a maximum after 5 hours and then declines.

The curve of basal metabolism showing its variation with age is discussed, and reasons are given for thinking that this increase of metabolism in youth is directly ascribable to growth.

The rationing of pigs for maintenance and growth is discussed, and it is concluded from the experimental results achieved that the curve of rationing for growth and maintenance, without fattening, cannot possibly be a two-thirds power curve

ROYAL INSTITUTION OF GREAT BRITAIN.

The General Monthly Meeting was held on November 5.

THE ROYAL SOCIETY OF ARTS.

On Wednesday, November 7, the inaugural address of the 170th session, entitled *Exhibitions*, was delivered by LORD ASKWITH, K.C.B., K.C., D.C.L., Chairman of the Council, and a Vice-President of the Society.

THE INSTITUTION OF MINING ENGINEERS.

ANNUAL GENERAL MEETING—PRELIMINARY NOTICE.

The thirty-fourth annual general meeting will be held at the rooms of the Geological Society, Burlington House, Piccadilly, London, W.1, on Thursday, November 29, 1923. An agenda-programme will be sent to members in due course.

MINERALOGICAL SOCIETY.

ANNIVERSARY MEETING, TUESDAY, NOVEMBER 6, AT 5.30.

The following papers were read:—

DR. L. J. SPENCER: *Euclase and Platinum from Diamond Washings in British Guiana.*

H. E. BUCKLEY: *The Anomalous Optical Properties of Freshly Prepared Mixed Crystals of Seignette Salt.*

COL. N. T. BELAIEW: *On the Genesis of Widmanstätten Structure in Meteorites and Terrestrial Alloys.*

PROF. L. R. WILBERFORCE: *Illustration and Detection of Inclined and Horizontal Dispersion in Bi-Axial Crystals.*

A. RUSSELL: *On the occurrence of the Rare Mineral Nadorite in Cornwall, and of Beraunite (Eleonorite) in Co. Cork, Ireland.*

A. F. HALLIMOND and F. R. ENNOS: *On Moravite from North Wales.*

DR. G. T. PRIOR: *On the Chemical Composition of the Ashdon Meteorite.*

THE CHEMICAL SOCIETY.

VAN DER WAALS MEMORIAL LECTURE.

This was delivered by DR. J. H. JEANS, Sec. R.S., at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, on Thursday, November 8, 1923, at 8 p.m.

The following papers were read at the Ordinary Meeting, Nov. 1:—

The Rapid Admixture of Hot Combustible Gases with Air, by F. M. CRAY and W. E. GARNER.

The minimum temperature at which hot combustible gases will ignite, when mixed with air at high speeds, must be higher than the normal ignition temperature. It should be possible to demonstrate the cooling effect of the air if sufficiently high speeds of projection of the hot gases be attained.

Experiments were carried out in which high explosives in steel containers, and acetylene and oxygen mixtures in glass bulbs, were exploded in a limited volume of air. The ignition of high explosives is to some extent determined by the volume of air into which the hot gases are projected, ignition occurring only when the ratio of

weight of explosive to volume of air exceeds a definite value.

In the experiments with acetylene and oxygen, the velocities of projection were not sufficiently high for this. Partial ignition occurred whatever the ratio of explosive mixture to the surrounding air, but ignition was less complete the higher the velocity of projection. Thus the greatest *conversion of acetylene to carbon monoxide* was attained with mixtures of equal proportions of acetylene and oxygen, this mixture, as was shown by Dixon, possessing the highest velocity of explosion of any acetylene-oxygen mixture.

Although carbon monoxide was present in the products from the explosion of all of the mixtures investigated, free carbon was *found only in those experiments where the* ratio of oxygen to acetylene exceeded unity. This behaviour is in agreement with the views of Bone on the mechanism of the processes occurring during the combustion of hydrocarbons.

The determination of Surface Tension from the maximum pressure in Bubbles. Part II., by SAMUEL SUGDEN.

An improved form of apparatus for measuring surface tension by the method of maximum bubble pressure was described. The method of calculation has been simplified.

The variation of Surface Tension with Temperature, and some related Functions. by SAMUEL SUGDEN.

The variation of surface tension with temperature is known to be represented with fair accuracy by an equation of van der Waals (1894),

$$\gamma = K_1\theta_c V_c^{-\frac{2}{3}}(1-m)$$

in which B is a universal constant. On the other hand, Ferguson (1916) allowed this exponent to vary slightly in order better to express the data of Ramsay and Shields (1893). Recently it has assumed a new interest, since Ferguson has shown that the simple relation, discovered by Macleod (1923), between surface tension and density can be deduced from the modified Ramsay-Shields law and the equation, if B is constant (1.20).

The data of Ramsay and Shields are now known to be in error owing to their correction for capillary rise in the outer vessel having been inadequate. The author now *calculates the necessary correction by ap*-[illegible]ing an earlier (1921) theory.

ma[illegible] the available figures it was shown, [illegible] associated liquids that:—

(a) The variation of surface tension with temperature can be represented accurately by:

$$\gamma = \gamma_0(1-m)^{1.20},$$

where γ_0 is a constant and m is the reduced temperature:

(b) Macleod's relation,

$$\gamma = C(D-d)^4,$$

where C is a constant and D, d are the densities of liquid and vapour respectively, holds with remarkable accuracy up to within a few degrees of the critical temperature.

(c) Van der Waals' relations connecting γ_0 with the critical constants are only approximately true.

Muconic and hydromuconic Acids. Part III.: Valency interchange in the Hydromuconic system, by E. H. FARMER.

It was shown in Part I. that the products of interaction of sodiomalonic and sodiocyanoacetic esters with ethyl muconate possessed the general structure $RO_2C\cdot CH_2\cdot CH_2\cdot CX:CH\cdot CO_2R$ and not $RO_2C\cdot CH:CH\cdot CHX\cdot CH_2\cdot CO_2R$. This constituted an addition of a 1:3-type; and in view of the difficulty in accounting for such a movement of the double bond as is necessitated if 1:2-addition be supposed to take place, it was suggested that the muconic system was to ome extent comparable in mobility with the glutaconic system.

This view is now seen to be incorrect. The muconic system is static, conforms to stereo-chemical theory, and adds the components of esters at the 1:2-position. The substituted dihydromuconic esters thus produced represent in their configuration interesting instances of the effect of an equilibrium between $\Delta\alpha$- and $\Delta\beta$-dihydromuconic esters in the presence of sodium alkoxide. This equilibrium, which favours the $\Delta\alpha$-form in the esters themselves, results in the conversion of the additive products under consideration into β-substituted glutaconic esters.

Experiments on the Synthesis of Substances possessing the Ladenburg Formula. Part I.: Derivatives of cyclopropylcyclopropane, by E. H. FARMER.

Recent syntheses by Beesley and Thorpe suggested a method for the syntheses of substances possessing the Ladenburg formula. The production of considerable quantities of various derivatives of cyclopropylcyclopropane was described.

CORRESPONDENCE.

To the Editors of THE CHEMICAL NEWS.

SIRS,—Could any of your readers inform me what is the lowest pressure at which the Joule Thomson Effect is produced on passing air through a small orifice at ordinary temperatures?

The lowering of temperature may be exceedingly small, and I am desirous of knowing what is the initial pressure which will produce the slightest cooling effect at ordinary room temperature. I do not want to produce a very low temperature, only down to 0° C. by continually cooling the incoming gas.—Yours, &c.,

A. J. FURSLAND.

Swansea, November 1, 1923.

ELECTRODE REACTIONS AND EQUILIBRIA.

A general discussion on this subject will be held by the Faraday Society, meeting at the Institution of Electrical Engineers, on Monday, November 26 next. The first session of the meeting will extend from 3 to 5 p.m., and will deal with "Conditions of Equilibrium at Reversible Electrodes." Sir Robert Robertson, President, will preside, and the introductory address will be given by Dr. E. K. Rideal. Among the speakers will be Professor Biilman, of Copenhagen, who will read a paper on "Some Oxidation and Reduction Electrodes and their importance to Organic Chemistry." After an interval for tea, the meeting will resume at 5.30 p.m., and will devote itself to the consideration of "Irreversible Electrode Effects, including Passivity and Overvoltage." Prof. F. G. Donnan, Vice-President, will preside over this session, and the introductory address will be given by Professor A. J. Allmand. At the conclusion of the meeting a dinner will be held at the Holborn Restaurant, to be followed by an informal conference. Members of the Chemical Society, the Physical Society, and the Institution of Electrical Engineers have been invited to attend this discussion. Others interested should apply to the Secretary of the Faraday Society, 10, Essex Street, London, W.C.2, from whom a full programme may be obtained.

PUBLICATIONS RECEIVED.

The *Colour Users' Association* have issued a little brochure for 1923-4 containing useful general and special information, including lists of members, dyestuff statistics, regulations, tables, and other data, which it is a convenience to have at hand.

BULLETINS ISSUED BY THE DEPARTMENT OF THE INTERIOR, UNITED STATES GEOLOGICAL SURVEY.

Bismuth, Selenium, and Tellurium, by VICTOR C. HEIKES. Pp. 16 to 24.

Lead in 1922, by C. E. SIEBENTHAL and A. STOLL. Pp. 27 to 36.

Zinc in 1922, by C. E. SIEBENTHAL and A. STOLL. Pp. 37 to 52.

Lead and Zinc Pegments and Salts in 1922, by C. E. SIEBENTHAL and A. STOLL. Pp. 77 to 85.

Asphalt and Related Bitumens in 1922, by K. W. COTTRELL. Pp. 7 to 13.

The Lime Belt of Massachusetts and Parts of Eastern New York and Western Connecticut, by T. NELSON DALE. Pp. VI. + 71.

Progress Report on a Sub-surface Study of the Pershing Oil and Gas Field, Osage County, Oklahoma, by W. W. RUBEY. Pp. 1 to 70.

Surface Water Supply of the United States 1919-1920. Part I.: *North Atlantic Slope Drainage Basins*, by NATHAN C. GROVER.

Surface Water Supply of the United States, 1919-1920. Part X.: *The Great Basin*, by NATHAN C. GROVER. Pp. VI. + 348.

Surface Water Supply of the United States, 1919 *and* 1920. Part XII.: *North Pacific Slope Drainage Basins*, by NATHAN C. GROVER. Pp. V. + 262.

Messrs. Theodor Steinkopff, of Dresden, have just published a volume on *Physical Chemistry as Applied to Internal Medicine*, by Prof. H. Shade, Director of the physico-chemical division of the Clinic at Kiel.

The development of physical chemistry has assisted in the progress of many sciences in recent years. That it has helped in medicine is well borne out by a perusal of this work.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

26037—Lantz, R.—Manufacture of naphthaquinone derivatives. Oct. 18.

26163—Oechslin, C.—Manufacture of substituted products of an aliphatic arsenic acid. Oct. products of an aliphatic arsinic acid. Oct. 19.

25665—Pereira, H.—Manufacture of perylene vat dye. Oct. 15.

25666—Pereira, H.—Manufacture of 3-10-perylene quinone. Oct. 15.

25936—Soc. l'Oxyhydrique Française.—Manufacture of hydrogen. Oct. 17.

Specifications Published this Week.

184462—Moeller, Dr. F.—Waterproofing cellulose or carbohydrates of the cellulose group.

199401—Pereira, H.—Reduction of dioxyperylene.

203347—Lilienfeld, Dr. L.—Manufacture of cellulose derivatives.

Abstract Published this Week.

203077—Synthetic drugs.—Pomaret, M., of 92, Rue Vielle du Temple, Paris, and May & Baker, Ltd., Garden Wharf, Church Road, Battersea, London.

Arsenobenzene derivatives.—Stable solutions of 3 : 3′-diamino-4 : 4′-dihydroxyarsenobenzene and like arseno bases with reducing sugars are prepared by acting with an organic base, for example *piperazine*, upon a neutral soluble condensation product of the arseno base having one or more *side chains directly linked to a nitrogen atom*, and then adding a solution of a reducing sugar; or the reaction may be effected in the presence of a sugar. In an example 3 : 3′-diamino-4 : 4′-dihydroxyarsenobenzene-N-methylene sulphoxylate dissolved in glucose solution is treated with piperazine; the solution is ready for use after standing for a few days. Specifications 112,984 and 117,283 are referred to. The Provisional Specification mentions *hexamethylenetetramine as a suitable* organic base.

Rayner & Co. will obtain printed copies [illegible] lished specifications and abstract only, [illegible] on post free for the price of 1s. 6d.

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THE CHEMICAL NEWS,

VOL. CXXVII. No. 3318.

CHEMISTRY AT THE BRITISH EMPIRE EXHIBITION (1924).

At the British Empire Exhibition at Wembley the national life of this country and of the newer nations overseas will reveal itself in every branch of its activities. In every art, craft and manufacture, and in agriculture, we hope to make a memorable display.

Clearly, therefore, we cannot neglect to make an exhibition of our progress and present position in science, more particularly in chemical science which is imperceptible to most, but nevertheless clearly intertwined with our progress and position in industry, with the preservation of our health and with our enjoyment of such amenities as our civilisation has as yet provided.

We are so familiar with the idea that we are behind other nations in chemistry, particularly behind Germany. I am not talking about the application of chemistry, but the study of chemistry and of research in chemistry at our universities, that the thought may arise, is it wise to make such an exhibit? Would it not be better, as chemistry is so fundamental, as our progress in industry depends so much upon our progress in pure chemistry, to conceal our position in this science—at least for a time—from the prying gaze of the world that will visit Wembley? The answer to that is this:—

The pure chemistry exhibit is being organised by a committee composed of representatives of the Association of British Chemical Manufacturers, of the Chemical Society, of the Society of Chemical Industry, of the Institute of Chemistry, of the Society of Dyers and Colourists, of the Federal Council of Pure and Applied Chemistry, in fact of all relevant scientific societies, supported and greatly assisted by the advice and co-operation of the Royal Society. It would appear, therefore, that in the minds of those qualified to express an opinion, that it will redound to the national advantage in every way for the world to see what the British men of science have done and are doing to build up the science of chemistry as it is known in the world to-day. That is the answer.

We may put it higher: The pure chemistry exhibit at Wembley will, without a doubt, for ever destroy the illusion, which had some justification in the past, that our university training and research in chemistry is below the highest standard of other countries.

This would not have been true in the same sense thirty years ago.

We have always had masters, giants of science. In a sense the exceptional man of genius and science belongs to the world. In the richness and the output of the many workers of talent, in the vigour of the teaching at the many universities, in the output of first-class work in every branch of chemical science, you find the true criterion of the national position in chemical science.

Thirty years ago we could not have shown this. The development of our chemical schools which we know to-day is comparatively new, and is as yet not appreciated by the general public. What is the importance of this?

It is of importance to the chemical industry for the world to know that behind it are great schools of chemistry, directed by great teachers of chemistry and inspired by great original workers in chemistry who can supply ideas and well-trained students to fertilise the chemical factories—otherwise arid wastes of pipes and tubs and vats and buildings.

It is also of importance to our university laboratories that their work and influence should be more widely known to the public who support them.

However, perhaps it has not occurred to everybody what an enormous advantage it is to the public to see with its own eyes and to be able to comprehend by the most charmingly delightful examples, things which were a few years ago entirely matters of metaphysical speculation. To quicken the imagination of our people, to give them some idea of the enormous interest—of which they are for the most part entirely unaware—of the simple things which surround their daily life, is one consequence of the result of this exhibit.

Nothing could be of greater importance than to give the general public, through the eye and in an interesting, fascinating way, greater appreciation of the value of chemical science in the affairs of life, and of the steps that precede great industrial or medicinal discoveries.

The following sections are being arranged by the conveners mentioned.

PHYSICS AND GENERAL CHEMISTRY.

"*Structure of the Atom,*" Sir *Ernest* Rutherford, LL.D., F.R.S.

"Spectroscopy," Professor J. C. McLennan, F.R.S.

"Crystallography and Crystal Structure," Sir Henry Miers, LL.D., F.R.S.

"Valency Theories and Theories of Chemical Combination," Dr. Arthur Lapworth, D.Sc., F.R.S.

"Photography," Dr. T. Slater Price, O.B.E., F.I.C.

"General Physical Chemistry," Professor F. G. Donnan, C.B.E., F.R.S.

INORGANIC CHEMISTRY.

"Atomic Weight Determination," Dr. Alexander Scott, F.R.S.

"Analysis: Hydrogen Ion Concentration," A. Chaston Chapman, Esq., F.R.S.

"General Inorganic," Professor E. C. C. Baly, C.B.E., M.Sc., F.R.S.

"*Flame, Fuel and Explosion Waves,*" Professor A. Smithells, C.M.G., B.Sc., F.R.S.

"Organic Chemistry," Dr. Henry and Professor F. L. Pyman, D.Sc., F.R.S.

"*Biochemistry,*" J. L. Baker, *Esq.*, F.I.C.

"Agricultural Chemistry," Sir John Russell, F.R.S.

"Sugars," Principal J. C. Irvine, C.B.E., F.R.S.

"Terpenes," Professor G. G. Henderson, LL.D., F.R.S.

"Plant Colouring Matters," Professor I. M. Heilbron, D.S.O., F.I.C.

"Coal Tar Colouring Matters," Dr. J. T. Hewitt, F.R.S.

"General Organic Chemistry," Professor J. F. Thorpe, C.B.E., F.R.S.

"Cellulose," C. F. Cross, Esq., B.Sc., F.R.S.

"Catalysis," Dr. E. F. Armstrong, D.Sc., F.R.S.

"Explosives," W. E. Reid, Esq., F.I.C.

"Plastics," Dr. W. R. Ormandy.

"Apparatus," Commander R. E. Stokes-Rees, R.N.

"Chemical Engineering," Professor J. W. Hinchley, A.R.S.M., F.I.C.

"Historical," H. B. Pilcher, Esq., of [illegible]

PROPYL-STANNONIC ACID.

By J. G. F. DRUCE, M.Sc. (LOND.), R.NAT.DR. (PRAGUE).

Three members of the series of organic stannonic acids have been described previously, namely, methyl-stannonic acid (*The Chemical News*, 1920, CXX., 229), ethyl-stannonic acid (*Trans. Chem. Soc.*, 1921, CXIX, 758), and isopropyl-stannonic acid (*Trans. Chem. Soc.*, 1922 CXXI., 1859, and this Journal, Vol. CXXV., 327).

The normal propyl-stannonic acid has now been isolated. The potassium salt was formed by the interaction of propyl bromide (or iodide) and an alkaline solution of potassium hydrogen stannite in accordance with the equation:—

$$C_3H_7X + KHSnO_2 + KOH = C_3H_7 \cdot SnO \cdot OK + KX + H_2O.$$

From this, the free stannonic acid may be obtained by careful neutralisation.

The reaction is not quantitative, although it does not fall far short of being so. The filtrate which remained after the separation of the propyl-stannonic acid had the unpleasant odour associated with tri-alkyl tin compounds.

When this solution was distilled, a quantity of an aqueous distillate, boiling at 100°, was obtained. It was found to contain tin and also bromine. Its penetrating odour suggested the probable presence of tri-propyl tin bromide.

The residue from the distillation experiments yielded a further distillate when treated at a higher temperature with excess of soda-lime.

This distillate was cloudy and oily, and was distinctly alkaline, although it left no residue on evaporation.

It had a most powerful and penetrating odour, resembling, but distinct from, garlic, and reacted with sulphuric, hydrochloric, and acetic acids, but owing to the small quantity available the amounts of the salts obtainable were not sufficient for analytical purposes. In all probability the substance was, or at least contained, tri-propyl tin hydroxide.

Recently, Lambourne (*Trans. Chem. Soc.*, 1922, CXXI., 2533) advanced evidence which indicated that methyl-stannonic acid was polymeric and had the structure:

since he was able to isolate tri- and penta-acetyl, benzoyl, and other derivatives.

Investigations are in progress with the object of ascertaining whether this is the case with the other members of the series, and whether it is supported by all the experimental facts.

In the present communication, the simple formula, α-$C_3H_7 \cdot SnO.OH$, has been adhered to, since it is possible to account for all the practical data presented in the experimental part.

When destructively distilled, the acid gave propyl alcohol, water, propylene and propane. The residue chiefly was stannous oxide, but stannic oxide was also present.

The decomposition may thus follow the three courses expressed by the equations:—

$C_3H_7 \cdot SnO \cdot OH = C_3H_7OH + SnO$

$C_3H_7 \cdot SnO \cdot OH = C_3H_6 + SnO + H_2O$

$C_3H_7 \cdot SnO \cdot OH = C_3H_8 + SnO_2$.

EXPERIMENTAL.

Preparation of α-Propyl-stannonic Acid.—Sixteen grams of propyl bromide (or in some experiments 22 gr. of the iodide) were added to a solution of potassium hydrogen stannite, obtained by treating 20 gr. of stannous chloride mixed with 60 cc. of water, with enough of a cold 10 per cent. solution of potassium hydroxide (about 240 cc.) to dissolve completely the precipitate of stannous hydroxide first formed.

Alcohol (abont 200 cc.) was added to make the mixture homogeneous. It was shaken at intervals during fourteen days.

The solution was then made almost neutral with dilute hydrochloric acid solution which was slowly added with stirring. The gelatinous precipitate was filtered off, washed with warm water until free from alkali, drained and dried.

When dry it was easily ground to a white amorphous powder.

On analysis—

0.8448 gr. gave 0.6480 gr. SnO_2;
Sn = 60.5 per cent.

0.7008 gr. gave 0.2902 gr. H_2O, and 0.4647 gr. CO_2; H = 4.6 and C = 18.1 per cent.

$C_3H_7 \cdot SnO \cdot OH$ requires Sn = 60, H = 4.1, and C = 18.5 per cent.

Propyl stannonic acid did not melt on heating, but decomposed in air at temperatures considerably above 300°, leaving a white residue of stannic oxide.

When destructibely distilled out of contact with air, it gave a little propyl alcohol (oxidised by chromic acid to propionaldehyde), some water (which coloured anhydrous copper sulphate blue), a quantity of an unsaturated hydrocarbon (presumably propylene), and a small volume of a saturated hydrocarbon (propane). Much of the dark residue was soluble in a hot dilute solution of hydrochloric acid, yielding a solution of stannous chloride. The white insoluble residue was reduced to tin by heating in a stream of hydrogen, and was thus stannic oxide.

Properties of α-Propyl-Stannonic Acid.—Propyl-stannonic acid was not soluble in water or any common organic solvent, except glacial acetic and other acids. It exhibited amphoteric properties, being soluble in both strong acids and strong solutions of the caustic alkalis.

Potassium Propyl-Stannonate, $C_3H_7 \cdot SnO \cdot OK$.—The potassium salt of α-propyl-stannonic acid was obtained by dissolving as much of the acid as possible in a warm 15 per cent. solution of potassium hydroxide. When cold, the supernatant liquid was placed in a vacuum desiccator over both concentrated sulphuric acid and sticks of potassium hydroxide.

After some days crystals of the potassium salt separated. These were washed several times with warm alcohol, to remove adhering potash, and dried.

On analysis—

0.4555 gr. gave 0.2920 gr. SNO_2;
Sn = 50.5 per cent.

0.4555 gr. gave 0.1839 gr. K_2SO_4;
K = 18.2 per cent.

$C_3H_7 \cdot SnO \cdot OK$ requires Sn = 51.0 and K = 16.7 per cent.

Potassium propyl-stannonate was very hygroscopic, and was obtained free from excess of alkali only with difficulty. It was soluble in water, but the solution readily hydrolysed, being alkaline to indicators and giving a flocculent deposit.

The sodium salt was similarly obtained and exhibited the same general properties as the potassium compound.

With solutions of calcium and barium chlorides, solutions of the alkali salts gave precipitates of the basic propyl-stannonates of these metals.

Dipropyl tin oxide, $(C_3H_7)_2 SnO$.—Dipropyl tin oxide was obtained as a white precipitate by heating propyl-stannonic acid with excess of a ten per cent. solution o

potassium (or sodium) hydroxide, under a reflux condenser for several hours. The precipitate was filtered off, washed till free from alkali, drained, and dried.

On analysis—

0.2695 gr. gave 0.1837 gr. SnO_2;

Sn = 53.4 per cent.

$(C_3H_7)_2SnO$ requires Sn = 53.8 per cent.

The oxide did not melt on heating, but decomposed at high temperatures, leaving a residue of stannic oxide.

It did not dissolve in water, alkalis or organic solvents. Hot concentrated solutions of hydrochloric and hydrobromic acids dissolved it, forming the corresponding chloride and bromide.

Propyl tin trichloride, $C_3H_7SnCl_3$.—This compound was obtained by boiling propylstannonic acid under a reflux condenser with a benzene solution of hydrochloric acid gas. When the resulting solution was evaporated in vacuo, colourless deliquescent prismatic crystals remained.

On analysis—

0.5050 gr. gave 0.2880 gr. SnO_2;

Sn = 44.93 per cent.

0.5050 gr. gave 0.8224 gr. AgCl;

Cl = 40.3 per cent.

$C_3H_7 \cdot SnCl_3$ requires Sn = 44.3 and Cl = 39.5 per cent.

The crystals of propyl tin trichloride were very soluble in water and most organic solvents. The aqueous solutions hydrolysed, especially on warming.

Propyl tin tribromide, C_3H_7 $SnBr_3$.—Propyl tin tribromide was obtained by dissolving the stannonic acid in concentrated hydrobromic acid. The substance possessed a darker colour than the trichloride, which it resembled in being deliquescent.

THE BRITISH CAST IRON RESEARCH ASSOCIATION.

The various researches detailed in previous announcements are progressing, reports upon same will be given in Bulletin No. 4, which is now being prepared.

Semi-Steel.—During the recent visit of Dr. Moldenke, of America, to this country, he expressed some very interesting remarks as to the manufacture and nomenclature of semi-steel. There is no doubt better name should be found for it, is equally no doubt that better manufacture will have to be adopted if its producton and use are to progress. The Association has carried out numerous investigations for its members, an has collected a large amount of data upo the methods adopted by various maker Although the Association are not yet in position to state that definite conclusio have been arrived at, they can offer co sidered advice to its members upon the be melting practice to adopt. This has be done in many cases with the result th mixture and melting processes have be improved. When the Association has co pleted its investigation there is no dou that it will be able to make such a report its members as will enable them to profi a material that will be of widespread us

Supplying Pig Iron on Analysis.—A c cular giving recommendations for supply pig iron on analysis has been circulated the Blast Furnace Owners in this coun by Dr. R. Moldenke and Mr. W. Wood, behalf of the American Society for Test Materials. The recommendations will carefully considered by this Association due course.

PROBLEMS SENT IN BY MEMBERS.

Several problems have been sent in ing the past month for assistance by Association, including the following:—fective gas engine cylinder casting; mixt for cast iron permanent mould; nature cast iron scrap for Cupola mixture; qua of ganister; corrosion of cast iron propell

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GENERAL NOTES.

SAFEGUARDING OF INDUSTRIE ACT.

PART I.—ARBITRATIONS UNDER SECTION

The Board of Trade has received for notices of complaint under Sub-section of Section 1, that

Rongalite,

Sodium Formaldehyde Sulphoxy and

Zinc Formaldehyde Sulphoxylate

have been improperly included in the of articles chargeable with duty under I. of the Act.

These complaints will be submitte due course to the Referee appointed by Lord Chancellor for the purposes of Sub-section, and any person inter should communicate immediately wit Assistant Secretary, Board of Trade (In tries and Manufactures Department), George Street, London, S.W.1.

DYESTUFFS (IMPORT REGULATION) ACT.

APPLICATIONS FOR LICENCES IN OCTOBER.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during October has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 520, of which 428 were from merchants or importers. To these should be added the 40 cases outstanding on October 1, making a total for the month of 560. These were dealt with as follows:—

Granted—423 (of which 381 were dealt with within 7 days of receipt).

Referred to British makers of similar products—75 (of which 63 were dealt with within 7 days of receipt).

Referred to Reparation supplies available—53 (all dealt with within 2 days of receipt).

Cancelled—1.

Outstanding on October 31, 1923—8.

Of the total of 560 applications received, 498, or 89 per cent., were dealt with within 7 days of receipt.

CANADA'S NON-FERROUS METALS.

Canada exported during the twelve months ended September 30 last iron and products thereof valued at $63,406,239, *compared with the previous year's total of* $35,647,293. The total value of non-ferrous metals exported was $57,169,208, as against $32,831,376 for the preceding twelve months, and shipments of these included:

	Quantity.	Value.
	cwts.	$
Aluminium, bars and blocks	167,439	3,059,445
Copper ore	351,128	3,469,307
Copper blister	431,719	6,042,835
Gold ore, dust, &c.	—	10,443,618
Lead	—	3,236,634
Nickel	561,508	10,080,020
	ozs.	
Silver ore and bullion	19,007,224	12,422,865
Zinc	—	2,556,332

Non-Metallic Minerals.

Exports from Canada of non-metallic minerals during the twelve months ended September 30, 1923, amounted in value to $29,728,160, as against $22,618,582, the total for the previous twelve months. They included:—

	Quantity.	Value.
	tons.	$
Asbestos	203,762	8,339,485
Coal	1,807,973	11,510,343

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, NOVEMBER 8.

Papers read:—

A. S. PARKES: *Studies on the Sex-ratio and related Phenomena—Fœtal Retrogression in Mice.* Communicated by Dr. F. H. A. Marshall, F.R.S.

R. A. FISHER: *The Influence of Rainfall on the Yield of Wheat.* Communicated by Sir John Russell, F.R.S.

The Rothamsted data for rainfall and wheat yields extend to 1854; these data have been utilised to calculate the average effect on the yield of rain at different periods of the harvest year, for plots under 13 different manurial treatments. The method is an extension of the method of partial correlation, applicable when the number of independent variates is very large and can be arranged in a continuous series. This has involved the analysis of the distribution of rainfall in each of the years; a significant and progressive change has been in progress in the distribution of rain. The elimination of such slow changes and others which appear in the yields has been effected by the method of polynomial fitting; this method is shown to minimise the errors involved in such alternative processes as the use of Variate Differences.

The several plots show marked differences in their response to rain, showing that it is not impossible for the farmer to adapt his manurial treatment to a wet or dry season. A large part of the differences may be ascribed to the effects of loss of soil nitrates by percolation; other effects not susceptible to this explanation, and not hitherto anticipated, include the losses on the highly nitrogenous plots due to late summer rain. The residual value of artificial nitrogenous manures appears from

these results to be considerably greater than has been thought.

Paper read in title only:—

D. Thursby-Pelham: *The Placentation of Hydrax Capensis.* Communicated by Prof. J. S. Gardiner, F.R.S.

Thursday, November 15.

Papers read:—

Sir William Bragg, F.R.S., and Prof. G. T. Morgan, F.R.S.: *Crystal Structure and Chemical Constitution of Basic Beryllium Acetate and Propionate.*

G. I. Taylor, F.R.S.: *Experiments on the Motion of Solid Bodies in Rotating Fluids.*

L. C. Jackson: *Investigations on Paramagnetism at Low Temperatures.* Communicated by Prof. H. Kamerlingh Onnes, For. Mem. R.S.

L. C. Jackson and Prof. H. Kamerlingh Onnes, For. Mem. R.S.: *The Magnetic Properties of some Paramagnetic Double Sulphates at Low Temperatures.*

H. H. Potter: *Some Experiments on the Proportionality of Mass and Weight.* Communicated by Prof. O. W. Richardson, F.R.S.

Papers read in title only:—

Lord Rayleigh, F.R.S.: *Further Studies on the Glow of Phosphorus and its Extinction by Moist Oxygen.*

Prof. H. A. Wilson, F.R.S.: *An Experiment on the Origin of the Earth's Magnetic Field.*

H. Robinson, D.Sc.: *The Secondary Corpuscular Rays produced by Homogeneous X-Rays.* Communicated by Sir Ernest Rutherford, F.R.S.

Lt.-Col. J. W. Gifford (with an Introduction by Prof. T. M. Lowry, F.R.S.): *Some Reractive Indices of Benzene and Cyclohexane.* Communicated by Prof. T. M. Lowry, F.R.S.

A. V. Butler: *A Note on "The Significance of the Electrode otential."* Communicated by Prof. J. W. McBain, F.R.S.

ROYAL INSTITUTION.

A General Meeting of the members of the Royal Institution was held on November 5, Sir James Crichton-Browne, Treasurer and Vice-President, in the chair. The thanks of the members were returned to Mr. F. Coston Taylor, for his donation of one hundred guineas to the Research Fund, and to Mr. Robert Mond, for his gift of busts and medallions of Dr. Ludwig Mond, Cannizzaro, Liebig, Berzelius, and others; statuette of Sir James Dewar, and many portraits and photographs. The death of Professor Jules Violle, an honorary member of the Institution, was announced, and a resolution of condolence with the family was passed.

Mr. H. A. Gwynne, Professor J. C. McLennan, and Colonel H. G. Wait were elected members.

THE PHYSICAL SOCIETY OF LONDON.

A meeting of the Society was held on Friday, November 9, at the Imperial College of Science, South Kensington.

A Demonstration of "Experiments on the Reproduction of Vowel Sounds" was given by Sir Richard Paget.

The following papers were read:—

The Scattering of Light by Carbon Dioxide and Some Organic Vapours, by Prof. A. L. Narayan, M.A. (presented by Lord Rayleigh).

Measurement of the Surface Tension of a Small Quantity of Liquid, by Dr. Allan Ferguson.

Proceedings of the meeting held on Oct. 26, Alexander Russell, M.A., D.Sc., in the chair:—

The President announced that Mr. F. E. Smith had been forced, owing to pressure of work, to resign his position as Honorary Secretary of the Society, and expressed the Society's warm appreciation of the value of the services he had rendered in that office.

The President further announced that Prof. A. O. Rankine had been elected by the Council to succeed Mr. Smith as Secretary.

Papers read:—

The Fine Structure of Some Sodium Salts of the Fatty Acids in Soap Curds, by S. H. Piper, D.S.O., B.Sc., and E. N. Grindley, B.Sc.

X-ray photographs of certain sodium salts of the fatty acids (soap curds) show lines due to reflections from planes with very wide spacings of the order 40 A.U. These planar spacings increase uniformly with the number of CH_2 groups in the molecule, indicating an effective length of 1.25 A.U. for the CH_2 group. These and other lines can be accounted for by assuming that the curds are in the smectic state described by Friedel.

Discussion.

Mr. G. Shearer said that in conjunction with Dr. Miller he had recently been examining compounds somewhat similar to those referred to in the paper, with similar results. The compounds he had dealt with were, however, solids, namely the heavier fatty acids and their esters. He also had found a regular increment in the spacing for each CH_2 radicle added, and his observations confirmed the supposition that the axes of the molecules are perpendicular to the strata in which they lie. The experiments are of special interest in that they measure the actual length of one or of two molecules. He congratulated the authors on the excellence of their photographs for a semi-liquid substance, which were exhibited at the meeting.

X-Ray Analysis of Solid Solutions, by E. A. Owen, M.A., D.Sc., and G. D. Preston, B.A.

The atomic structure of solid solutions of copper-aluminium, aluminium-magnesium, and copper-nickel has been examined by the X-ray spectrometer. In each case it was found that the solute atom replaces an atom in the lattice of the solvent, the substituion being accompanied by a distortion of the lattice.

A saturated solution of aluminium in copper shows that the aluminium expands the copper lattice from 3.60 A to 3.65 A. The effect of adding nickel to copper was to produce a contraction of the lattice, the contraction being approximately a linear function of the atomic percentage of either constituent. The addition of 8 per cent. magnesium by weight to aluminium causes the average parameter of the aluminium lattice to increase from 4.05 A to 4.10 A. The addition of 8 per cent. aluminium by weight to magnesium decreases the average parameter of the hexagonal lattice of magnesium from 3.17 A to 3.15 A, and increases its axial ratio from 1.63 to 1.66.

An examination of the eutectic alloy of aluminium and copper showed that this alloy consists of a mixture of two distinct substances with different space lattices. The one substance being $Cu\ Al_2$ and the other a substance the space lattice of which could not be distinguished from that of pure aluminium.

The intermetallic compound $Cu\ Al_2$ was found to possess a simple tetragonal lattice of side 4.28 A and axial ratio 0.562, the copper atoms being at the corners and the aluminium atoms at the centres of the four small faces.

The atomic structure of the compound Cu Al resembles that of a solid solution of aluminium in copper, but the distortion is considerably greater. The material was found to have a face centred trigonal lattice of side 3.89 A and an angle between the axes of 94.6°, the 111 planes being composed alternately of aluminium and copper atoms.

Discussion.

Mr. F. Twyman commented on the fineness of the definition in X-ray photographs, remarking that it might have been expected that owing to penetration of the rays into the material and from other causes, considerable blurring would occur, yet the lines shown are not more than a hundredth of an inch wide.

Dr. E. A. Owen, in reply, said that the good definition might be ascribed (1) to the fact that the rays do not penetrate to any great depth in the reflecting material, owing to their being almost completely reflected by the outer layers of atoms; and (2) to the well-known focussing effect obtained when the photographic plate and the source of radiation are equidistant from the reflecting surface.

Cohesion, by Herbert Chatley, D.Sc., A.Inst.P.

The paper traced the consequences of assuming that the alternately positive and negative atoms in a crystal may be treated as doublets attracting according to an inverse ourth-power law, while the electron fields surrounding the atomic nuclei repel according to an inverse tenth-power law. It is shown that the numerical results agree fairly well with the facts as regards the strain which produces rupture in solids, and

as regards the rate of change of compressibility with compression in liquids.

Discussion.

Prof. A. O. Rankine said that while he recognised that the numerical results of the theory were fairly consistent with experimental values, he could not help suspecting that this was a coincidence. What little is known of the nature of cohesion seems to indicate that the laws concerned must be far more complicated than a simple inverse power law. The doublets would only attract according to an inverse fourth-power law at a distance great compared with the distance apart of their components, not at the distances which actually obtain in a crystal; and, again, in a crystal the electron swarms of neighbouring atoms must be very close to one another in certain regions, and it is difficult to see why the particular law adopted in the paper should hold. Further, the field of force round an atom must be regarded as having an axis, not as being spherically uniform and independent of direction. It seems unsatisfactory also to test a theory based on the structure of a solid crystal by measurements made on water in the liquid state.

Dr. D. Owen said that, while agreeing with the previous speaker that the formulæ proposed in the paper were open to objection, any hypothesis seemed better than none. Calculations such as the author had made might be of value in suggesting limiting values of elasticity and density under great stresses; they permitted, for example, of interesting speculations as to the conditions of matter deep in the earth's interior.

THE FARADAY SOCIETY.

Papers read at the meeting on November 12:—

Part I.—*The Electrodeposition of Manganese*, by A. J. ALLMAND and A. N. CAMPBELL.

The problem of the cathodic deposition of manganese from aqueous solution has received little attention in the past. Bunsen states that he obtained the metal by electrolysis of aqueous manganous chloride solutions, using the apparatus employed in the deposition of chromium. The metal [illegible] be [illegible]ted as sheets 1 sq. cm. in area; it [illegible] looking, and oxidised almost as rapidly as potassium. If the current density were reduced, mangano-manganic oxide came down. Moore states that metallic manganese may be deposited as such from a neutral solution containing a large excess of ammonium sulphocyanide; a powerful current is necessary. Smith and Frankel find that, if an excess of potassium sulphocyanide be present, the metal comes down in greyish-white compact form. Under the conditions specified, the current must be low. The metallic deposit is inclined to oxidise rapidly. Van Arsdale and Meier give results of some experiments conducted on the electrolysis of manganese sulphate solutions. These will be referred to in more detail below, as they were to a large extent repeated by the present authors, to whom the paper was unknown when the work was started. Finally, Foerster quotes some results obtained by Grube, who states that very pure manganese can be obtained by electrolysis of a 6-7 N. $MnCl_2$ solution, separated by a diaphragm from the anode. The electrolyte is also 1.5 N. with respect to NH_4Cl and 0.1 N. with respect to HCl. The current density is 20 amps./d.m.[2] The electrolyte is strongly stirred, and its temperature 30°. The current efficiency is said to be between 50 and 60 per cent., and the purity of the deposit 99.9 to 100 per cent. "There is a marked tendency for the deposit to sprout at the edges of the cathode as a result of the high current densities used. This can, however, be overcome by arranging that the cathode fills the whole cross-section of the cell, and manganese is then obtained as a smooth microcrystalline deposit, which can be removed from the copper cathode in the form of coherent sheet." In later papers Grube and Metzger refer to sheets of metal 1 mm. thick made by this method.

The problem then was the working out of the conditions for the successful electrodeposition of a highly electropositive metal from aqueous solution. We decided in the first instance to use as electrolytes simple manganese salts. It could be predicted in advance that the electrolysis would be favoured by a high metallic salt concentration and by a low hydrogen ion concentration. A high current density was also likely to be advantageous. With regard to temperature, the matter was more complex. To take extreme cases, if manganese were a metal like zinc, with high hydrogen overvoltage and small irreversible resistance to cathodic deposition, a low temperatu

would be better; if like iron, with small hydrogen over-voltage and large irreversible cathodic effects, then high temperatures would be better. We commenced on the supposition that it would behave more like iron than like zinc, a view which turned out to be only partly correct, as both high hydrogen over-voltage and high irreversible resistance to manganous ion discharge were found.

It was found that the effects of changes in composition of electrolyte, current density, temperature, and type of cell influenced the deposition.

Pure manganese in coherent form can be prepared in small quantity with a current efficiency of 40-50 per cent.

Attempts to prepare larger amounts in coherent form have so far been unsuccessful.

A large number of experiments were carried out with the object of improving the deposit in view, without any striking success.

A variety of addition agents were tried, using the standard manganese sulphate and ammonium sulphate electrolyte. None produced any marked improvement, and in several cases (*e.g.*, gum arabic, dextrine, gelatine) the deposit was made much less pure.

With the same electrolyte, an experiment was done, making use of a burnisher (an ebonite strip) pressed against the rotating cathode. The deposit obtained was smooth and dense, but the current efficiency was reduced to 8.6 per cent.

Other electrolytes were tried. The use of sulphocyanide gave a more coherent but less pure deposit. The use of a mixture of manganese and ammonium perchlorates also led to nothing, as the whole catholyte hydrolysed with great rapidity, becoming filled with manganous hydroxide.

Further experiments are being carried out.

The Cathodic Behaviour of Aloys.—Part I.: *Iron—Nickel Alloys*, by S. GLASSTONE, M.Sc., PH.D., University College, Exeter.

Very little work has been done on the measurement of polarisation voltage at electrodes composed of metallic alloys, and therefore investigations were undertaken with the hope of throwing some light on the problem of over-voltage and allied phenomena. In working with alloys that are prepared from a fused mixture of the metals, the structure, and no doubt the properties of the allow as an electrode, will depend upon the method of cooling. Further, the surface skin will probably be different from the rest of the alloy. The object of this work was to investigate the cathodic behaviour of alloys, as well as the electrolytically deposited pure metals for comparison, along three lines: (1) to measure the cathodic potential during deposition from a solution of mixed salts, (2) to determine the potential required for hydrogen liberation in sulphuric acid and sodium hydroxide solutions, *i.e.*, "over-voltage," and (3) to investigate the action of depolarisers. Schlötter has shown that the reduction efficiency of any particular cathode in potassium chlorate solution is greatly influenced by depositing upon it traces of another metal in amounts insufficient to cover the surface of the cathode completely. Thus the system electrode metal—deposited metal—hydrogen might be more or less efficient for the purposes of reduction than the original electrode system before metal deposition. Since an alloy at which hydrogen is being evolved as a result of electrolysis, resembles to a very great extent the electrode system used by Schlötter, it appeared that a systematic investigation of the cathodic behaviour in the presence of depolarisers would be of considerable interest.

Examination of the cathodic behaviour of iron-nickel alloys, deposited from solutions of varying proportions of ferrous and nickel sulphates, from several standpoints has brought to light a number of new facts concerning their electrode deposition, over-voltage and action in the presence of depolarisers. Suggestions have been offered to account for some of the observed facts, but a fuller discussion of their significance in connection with the theories of over-voltage, delayed cathodic deposition and of cathodic reduction, must be left until further information is available.

The Volumes Occupied by the Solute Atoms in certain Metallic Solid Solutions and their Consequent Hardening Effects, by A. L. NORBURY, M.Sc., University College, Swansea.

The object of this research was to determine the densities of certain copper α-solid solution alloys, to calculate the volumes that the solute atoms were occupying in each case, the ultimate object being to compare the values so obtained with the hardness values of the same alloys.

In order to obtain accurate values, the

effects of annealing temperature and cold-work on the density of copper were first studied. The densities of the copper α-solid solutions were then determined, and the results calculated in a certain manner in order to estimate the "atomic volumes" occupied by the solute atoms in each case.

The results obtained were then compared with the hardness values, and a certain relationship was brought out. It was also found that the solute atoms were not occupying their normal atomic volumes, but that in each case a contraction or expansion had taken place—the amount of contraction or expansion apparently increasing as the "chemical affinity" of the solute for the solvent increased.

The paper dealt with the method of determining densities; the effect of annealing temperature and cold-work on the density of cathode copper; the density of commercial copper, and of certain copper α-solid solutions. It also included the calculation of "mean atomic volumes" and comparison of the latter with hardness data, and suggested an explanation of hardening effects of elements in solid solution.

In density determinations errors due to surface-tension effects between the surface water and the suspending wire were eliminated by the use of a compensating platinum wire.

Cold-hammering had the effect of closing up minute blow-holes in copper. Very severe cold-hammering set up stresses and strains in the metal which probably caused local increases and decreases in density. Otherwise cold-hammering did not affect the density.

Commercial copper has a distinctly lower density than cathode copper.

For theoretical purposes there are certain advantages in calculating density results as "mean atomic volumes."

When an element is distributed in solid solution as single atoms replacing single atoms of the solvent in the space-lattice of the latter, the hardening effect is, in general, proportional to the difference in size of the solute and solvent atoms. The above relationship does not, however, hold in certain exceptional cases (*viz.*, Si in Cu and Na in Pb), which appear to arise when the solute has an exceptionally strong "chemical affinity" for the solvent. In such cases it is suggested that the solute exists in [illegible] solution in the form of molecules of an [illegible]etallic compound having a different [illegible]e from that of the solvent. The interference with slip and consequent hardening being relatively much greater in this type of solid solution.

When an element forms a solid solution with another element, there is a certain contraction or expansion which seems to be large or small according to whether the "chemical affinity" between the elements is large or small.

From the theoretical point of view it was thought interesting to ascertain whether cold-hammering increased the hardness of each of the solid solutions to the same extent.

The solid solutions were therefore reduced first 60 per cent. in thickness and later 90 per cent. in thickness and their hardnesses measured after each reduction.

It was difficult to hammer all specimens to exactly the same amount, and this factor makes the results somewhat erratic; they seem, however, to be sufficiently accurate to show that the nickel-copper solid solutions have hardened relatively less than any of the other solid solutions, which appear to have hardened to equal extents.

The Catalytic Decomposition of Hydrogen Peroxide Solution by Blood Charcoal, by J. B. Firth, D.Sc., and F. S. Watson, M.Sc.

Hydrogen peroxide has been shown to be decomposed by a great variety of substances. Fillipi showed that all powders decompose hydrogen peroxide, the velocity of decomposition being proportional to the exposed surface of the added powder and independent of the concentration of the hydrogen peroxide. Lemoine found that charcoals obtained in the decomposition of wood, coconut and sugar are efficient catalysts of hydrogen peroxide; the catalytic effect being apparently correlative with their sorptive power for gases. Clayton showed that hydrogen peroxide does not volatilise appreciably from its aqueous solutions at 50° to 60° C., and the rate of decomposition is not affected by stirring. Rideal and Thomas show that hydrogen peroxide is decomposed by Fuller's earth. The catalytic activity in the decomposition of the hydrogen peroxide is not dependent on the adsorptive power; it would appear that the iron content of the Fuller's earth may be the governing factor. On applying the equation for a unimolecular surface reaction the velocity coefficient is constant for a given sample of Fuller's earth. The authors have shown that ordinary pure sugar carbon gives rise to only

very slight decomposition of hydrogen peroxide in aqueous solution, but the rate and extent of the decomposition increases considerably as the activity of the carbon is increased, and also with rise of temperature. The activity of the carbon gradually decays during the reaction. In a further paper the authors described experiments with specimens of carbon from other carbohydrates in which it was shown that the rate of decomposition varied considerably with the different carbons, but the fundamental difference is in the initial activity. The activity falls rapidly after the first few minutes, becoming ultimately very slight, even though the solution contains a fair proportion of undecomposed hydrogen peroxide. The object of the present investigation was to study the decomposition of hydrogen peroxide solution by blood charcoal, before and after activation treatment. Whereas in previous experiments relatively pure carbons were used; in the present case the charcoal contains appreciable quantities of impurity, mainly iron. Experiments were therefore carried out in order to determine as far as possible the influence of this impurity on the rate of decomposition of the hydrogen peroxide.

The blood charcoal used gave 8.82 per cent. of ash which consisted almost entirely of iron oxide. After treatment with hot aqua regia, the ash content was 7.30 per cent. It was then subjected to treatment with aqua regia for a month, the ash content becoming 6.32 per cent. Some of this charcoal was further treated with bromine for several days, after which the ash content was 5.79 per cent. In each case all soluble material was extracted by washing with boiling distilled water until the filtrate showed no indication of iron or halogen.

A sample of the charcoal was taken after each purification process. It was dried at 120° C. in an air oven, and the catalytic activity determined in each case. The hydrogen peroxide solution used contained 240.5 cc. of available oxygen per 25 cc. of solution: 0.25 grams of the charcoal and 25 cc. of the hydrogen peroxide solution were used in each experiment, and the temperature of experiment 18° C. The reaction velocity coefficients were calculated from the equation for a unimolecular surface reaction $dx/dt = K(a - x)$ to the Naperian base and the minute as unit of time.

The charcoal showed moderate catalytic activity in the decomposition of hydrogen peroxide solution.

This was considerably increased by previous heating in a vacuum at 600° C. and 900° C., and was still further increased by previous sorption of iodine from solution and from which the iodine had been subsequently completely removed.

The activity of an activated charcoal consists of two types, one which is termed α activity which is very rapid, but ceases after a few minutes, and a second termed β activity, which may persist for several hours. Both types may be increased by activation methods. In ordinary blood charcoal α activity is absent.

The introduction of iron into sugar solution prior to carbonisation considerably increased the activity of the charcoal, by an amount, greater than can be accounted for, by the iron alone, and it is suggested that the iron acts as a spacing agent thereby increasing the activity of the carbon itself.

The velocity of decomposition was shown to vary with the concentration of the hydrogen peroxide solution.

The proportion of hydrogen peroxide decomposed was determined by *both* the activity of the charcoal and the concentration of the hydrogen peroxide solution.

In the case of the highly active carbons, the heat generated by the rapid decomposition of the hydrogen peroxide raised the temperature of the reaction, temporarily, by several degrees, which further facilitated the decomposition of the hydrogen peroxide and thereby maintained the velocity of reaction at a higher level, until this heat had been dissipated.

The Properties of Powders.—Part VIII.: *The Influence of the Velocity of Compression on the Apparent Compressibility of Powders*, by E. E. Walker.

When a powder is compressed in a cylinder by a constant load, the velocity of compression is very high to begin with and then rapidly falls-off, but no case has been observed so far where it falls off to zero before the powder is completely compressed.

This has now been investigated. Observations were made on the height of the plunger after various intervals of time, the load being kept constant. As a rule the load was applied by means of a small Tangye press, and kept constant by manipulation of the hand-operated oil pump—but in certain cases where it was necessary to keep the load constant for several hours a dead load was employed. The load was applied as rapidly and gently as possible, and zero

time taken from the moment at which the full load was applied. On account of errors arising from the estimation of zero time, observations made in less than 20 seconds were liable to considerable error.

The isobaric curve has been correlated with the value of the ratio:—

$$\frac{\text{resistance to impact}}{\text{resistance to static load}}$$

and further evidence for the validity of the classification of powders suggested in Part VI. of these studies has been obtained.

The exceptional readiness with which powdered ammonium nitrate shrinks has been shown to be dependent chiefly on the high value of its velocity coefficient.

The powders examined were shown to fall into three classes.

Substances in Class I. are regarded as normal substances, which are compressed by deformation of the particles both when static loads are employed and when compression is brought about by the impact of falling weights.

Substances in Class II. are regarded as behaving normally when they are compressed slowly by static loads, but when the compression is brought about suddenly by blows the particles are broken down into fragments which fall together into closer order, so that the resistance to compression is much less than the calculated value to begin with. As compression proceeds further disintegration takes place, causing an increase of resistance analogous to the hardening of metals by cold working.

In Class III. conditions are exceedingly complex since disintegration is caused both by slow and by rapid compression (impact), and accordingly there is no connection between calculated and observed values. Calcium carbonate is an example of this total lack of agreement.

An Investigation of Smoluchowski's Equation as Applied to the Coagulation of Gold Hydrosol, by LEONARD ANDERSON, B.Sc., PH.D.

As regards the kinetics of coagulation of colloidal solutions the Smoluchowski equation is the only one which has a theoretical basis. Freundlich deduced an equation, based on measurements of the variation of the viscosity of a sol during coagulation, giving the relationship between time and the amount of precipitated colloid. However, no definite relationship is known to exist between the size of particles and viscosity.

According to Smoluchowski's theory, each particle in a homogenous sol possesses a sphere of attraction R, within which the attraction is so strong that any other particle, whose centre enters this sphere, is firmly held.

In an originally uniform sol, whose particles have been completely discharged, the initial number of particles whose centres are less than R apart is vanishingly small.

In course of time, Brownian movement brings the particles into all possible configurations. In consequence of Brownian movement and of the existence of "spheres of attraction" an irreversible state of coagulation is finally set up.

Smoluchowski, combining probability considerations and the laws of diffusion, derives a series of equations which give the rate of disappearance of the particles in a colloid solution during "rapid" coagulation. The following equation gives the rate of disappearance of primary particles:

$$v_1 = \frac{v_0}{(1 + \beta t)^2}$$

where v_0 is the number of primaries at zero time, v_1 is the number of primaries at a time "t," and β is a constant equivalent to $4\pi DRv_0$, where D is the diffusion coefficient and R is the radius of the sphere of attraction.

Smoluchowski also attempted to extend his theory to slow coagulation. Colorimetric determinations of the rate of coagulation of gold sols by HCl, KCl, $BaCl_2$, and $AlCl_3$ were carried out using Hatschek's method.

These experiments now brought forward indicate that or the coagulation of gold sols by means of the electrolytes chosen, there is a "rapid" region in which Smoluchowski's equation holds. The constancy of is quite good, especially in the case of barium chloride as electrolyte. In a region of smaller electrolyte concentration, an excessive slowing down in the speed of coagulation with time is observed. This is in agreement with the data of Kruyt and Ark and also with the one case of Mukherjee and Papaconstantinou in which the value of falls.

The general conclusion arrived at is that the Smoluchowski equation is strictly limited in its application.

Smoluchowski asserts that the curves depicting slow and rapid coagulation should

have a similar form, the only varying factor being the probability that an impact will give union.

The data obtained, however, show that coagulation proceeded even more slowly than would be expected on the basis of a bimolecular process. Furthermore, if primaries did disappear simply by union with each other, it would follow that once coagulation has commenced it should proceed until no more primaries are left. On this basis incomplete colour change from red to blue should not be possible, since any red colour remaining would indicate unchanged primaries (attributing the red colour to the latter). But incomplete colour change does occur and depends upon the concentration of the electrolyte present. This phenomenon admits of two explanations:

1.—It may be due to the possibility that the rate of disappearance of primaries is counterbalanced by an opposing effect, *i.e.*, primaries are being reformed either by spontaneous disruption of complexes or by collision of complexes with each other. Such reversibility, however, would seem to entail a behaviour, on dialysis, of incompletely coagulated sol which has not yet been observed.

2.—A more probable explanation would seem to be that the initial primary particles (giving the red colour) are *unequally* charged. In the case of slow and eventually incomplete coagulation very small amounts of electrolyte are used, and it is conceivable that the amount adsorbed is not sufficient to reduce the charge of some of the particles (which initially carry an excessive charge) below the critical limit which will permit coagulation to take place.

If this conception of unequal charge is correct, the Smoluchowski equation could not be expected to be applicable in general.

In reviewing the whole problem of coagulation, it would appear that the Smoluchowski equation in its present form is limited in its application. Before it can be applied to all types of coagulation it apparently requires modification to allow for the two factors:

(*a*) The decrease of the probability factor as coagulation proceeds.

(*b*) The existence of incomplete coagulation as a consequence of unequal, and in some cases therefore, of excessive initial electrical charge on the primary particles.

(To be continued next week.)

THE CHEMICAL SOCIETY.

ORDINARY SCIENTIFIC MEETING,

THURSDAY, NOVEMBER 15.

The following papers were read:—

Ring-chain Tautomerism. Dynamical Evidence relating to the Mutarotation of the Sugars, by J. W. BAKER, C. K. INGOLD, and J. F. THORPE.

The additive Formation of Four Membered Rings. Part III.—*A system of Nomenclature for Heterocyclic Four Membered Rings and the Formation and Properties of some Derivatives of β-methylenediiminoxide*, by C. K. IGNOLD.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The seventy-third general meeting was held at the house of the Royal Society of Arts, on Tuesday, November 13. The following paper was read:—

Galician-Canadian Pole Tool Fishing Methods, by ALBERT MILLAR, A.M.I.MECH.E., M.INST.P.

THE ROYAL SOCIETY OF ARTS.

On Monday, November 12, the Cantor Lecture (1.), entitled *The Cultivation of Cocoa in British Tropical Colonies*, was delivered by MR. SAMUEL HENRY DAVIES, M.Sc., F.I.C.

At the Ordinary Meeting, on Wednesday, November 14, a lecture entitled *Téléphotographie, Télautographie, Télévision (Avec Expériences et Projections)*, was delivered by MONSIEUR EDOUARD BELIN (in French). Mr. Alan A. Campbell Swinton, F.R.S., late Chairman of the Council, presided.

The Royal Society of Arts, which was founded in 1754 for the encouragement of arts, manufactures and commerce, held the opening meeting of the 170th session on Wednesday evening, November 7, when Lord Askwith, K.C.B., the Chairman of the Council and a Vice-President of the Society, delivered his address on *Exhibitions*.

For the subsequent meetings before Christmas the following arrangements have been made:—

November 21.—J. A. KNOWLES, *Forgeries of Ancient Stained Glass.* The Earl of Crawford and Balcarres, K.T., P.C., will preside.

November 27.—THE VISCOUNT BURNHAM, C.H., LL.D., D.LITT., M.A., *The West Indies.*

November 28.—SIR HENRY JOHN GAUVAIN, M.A., M.D., M.CH., Medical Superintendent of the Lord Mayor Treloar Cripples' Hospital, *The Effect of Sun, Sea and Open-air in the Treatment of Disease.* The Rt. Hon. Arthur Neville Chamberlain, M.P., will preside.

December 5.—ARTHUR WILLIAM HILL, M.A., Sc.D., F.R.S., F.L.S., Director of the Royal Botanic Gardens, Kew, *The Work of the Royal Botanic Gardens, Kew.* Charles Albert Seward, M.A., F.R.S., F.G.S., F.L.S., Professor of Botany at the University of Cambridge, will preside.

December 7.—WILLIAM FOSTER, C.I.E., B.A., Registrar and Superintendent of Records, India Office, *The Archives of the Honourable East India Company.* (Sir George Birdwood Memorial Lecture.)

December 12. — SIR FRANK BAINES, C.B.E., M.V.O., Director of Works, H.M. Office of Works, *The Preservation of Historic Buildings and Ancient Monuments.* Sir Aston Webb, K.C.V.O., C.B., P.R.A., will preside.

December 17. — WILLIAM C. NOXON, Agent-General for Ontario, *Emigration within the Empire.*

CORRESPONDENCE.

NATIONAL CERTIFICATES IN CHEMISTRY.

To the Editors of THE CHEMICAL NEWS.

SIRS,—About three years ago the Board of Education established with the Institute of Chemistry a joint committee for the purpose of granting, under conditions, National Certificates in Chemistry to students in technical schools and colleges. These certificates are Part-time Course Certificates, (1) Ordinary, (2) Higher, and Full-time Course Certificates in (*a*) Chemistry, (*b*) Applied Chemistry. An institution wishing to prepare students for any of these certificates must submit schemes of its own, which its students must follow. This seems a clumsy feature of the arrangement. *Every institution devises its own scheme or* schemes, sets the examination papers at the end of the course, and marks the scripts by means of its own teachers, the joint committee, having previously approved of the local schemes, finally appearing as assessors, who supervise the questions set, revise the marking of the papers, satisfy themselves about the laboratory work done by the candidates, and finally issue certificates to those who are successful.

All this is in accordance with the apparent policy of the Board of Education to make technical schools quite local in their character, and to encourage them to cater specially for the technical needs of their locality. Hence, the idea of a separate scheme from each institution has been evolved.

This policy of localisation does not satisfy the best type of students in the technical schools, who are not able to express their wants. Localisation does not tend to promote good general education, nor does it give students a wide outlook.

The students in the technical schools are there voluntarily. For various reasons they are not able to pursue their education in the day-time. They get their education in their spare time, generally after a day's work, and large numbers attain responsible positions and become as efficient as those who have done full-time work.

Such earnest students develop a longing for some distinction, in the form of a degree or diploma, the value of which is well-known and recognised all over the country. From my personal acquaintance I know that many look with longing eyes at London University degrees, but they are met with the stumbling block that they did not matriculate at the outset. For those in chemical trades there is the Institute of Chemistry, whose Fellows and Associates have a recognised standing. Spend what time they may in a technical school, study what subjects they may, make themselves as efficient as they may, all their work does not lead in the direction of a recognised distinction. True it is that certain institutions provide training in the evening which is recognised by the Institute of Chemistry but they are situated in only 13 large towns in England and Scotland (not in Wales) What are the prospects of students else

where? They are in a local groove, with no chance of getting out. The National Certificates, after all, are only local certificates, blessed by the Joint Committee, with an implied intimation, not an open one, that the holders are in a class to themselves, in which they must remain, because there is no intimation anywhere that a certificate can be used by the holder towards gaining any further qualification.

An opportunity has been missed of furthering the cause of education by assisting those students who will work if properly directed and encouraged.

Something should be done. The Institute of Chemistry already recognises evening training in 19 institutions. Let the Institute say that, *providing a student has previously passed an approved preliminary examination*, the subsequent gaining of one or more national certificates shall be regarded as so much training towards the qualification for the associateship. What would be the effect upon students in technical schools? It would be an incentive to those who do not possess it, to work first of all for an approved preliminary certificate, which alone would do their general education some good. Technical school students often lack a good general education. They are so eager to get on to trade work that they neglect a continuation of school work. Having passed an approved preliminary examination which the Institute will accept, the student could work for such National Certificates as his particular technical school is approved for, fully knowing, and thereby encouraged, that any certificate gained will be a step towards a coveted qualification. If he finds that subsequently the varied chances of life bring him within reach of an institution on the Institute of Chemistry's recognised list, he could take advantage of it, knowing that his previous work will secure some remission from the four or five years' period now required.—Yours, &c., A.P.

November 5, 1923.

THE PREPARATION AND PROPERTIES OF SILVER STIBIDE.

To the Editors of THE CHEMICAL NEWS.

SIRS,—Silver stibide has been known since the year 1896 by the existence of an angle on the cooling curve of silver antimony alloys (Henri Gautier, *Comptes Rendus*, 1896, CXXIII., 172-174). C. T. Heycock and F. H. Neville (*Proc. Roy. Soc.*, 1896, X., 160-164) deduced evidence definitely giving it the formula Ag_3 Sb.

In 1910 Th. Liebisch (*Sitzungsfer K. Akad. Wiss., Berlin*, 1910, 365-370) found that most specimens of silver stibide from Andreasberg corresponded to the formula Ag_3 Sb. The mineral dyscrasite (Ag crystallises in the rhombic system, and its colour is silver white. On exposure to air and light it acquires a dull grey or yellow colour.

In a previous paper by the author (*Chemical News*, 1923, CXXVI., 275) it was shown that stibine could be detected by passing it through some concentrated silver nitrate. If this is performed, using dilute silver nitrate in the cold, then the action is found to go according to the equation:—

$$SbH_3 + 3Ag\,NO_3 = Ag_3\,Sb + 3HNO_3.$$

The silver stibide formed was filtered off, washed and dried, when it was obtained in the form of silver white crystals, which crystallised in the rhombic form.

The properties of silver stibide are remarkable by the fact that it is totally insoluble in both hot and cold, concentrated and dilute, sulphuric and hydrochloric acids. It is, however, soluble in boiling dilute nitric acid, giving off nitrous fumes, but is insoluble in the cold dilute acid.—Yours, &c.,

EDWARD J. WEEKS, M.Sc., F.C.S.

East Dulwich, S.E.22.

NOTICES OF BOOKS.

Oil Facts and Figures, October, 1923. Pp. 62. London: F. C. Mathieson & Sons, 16, Copthall Avenue, E.C.2. 1s. 6d.

This book contains a list of the producing oil companies, with the area and situation of the oil fields and the number of wells.

Besides the usual financial details, it gives the end of the financial year and the highest and lowest prices of shares for the years 1920 to (mid-October) 1923. The monthly output of a number of companies is contained in a separate table.

The large amount of information in a small volume makes it a valuable pocket reference book. Future editions might also indicate to which combine any particular company belongs. G.H.M.

BOOKS RECEIVED.

Practical Mathematical Analysis, by H. VON SANDEN, with examples by the trans-

lator, H. LEVY, M.A., D.Sc., F.R.S.E. *Pp.* XI. + 195. 1923. Messrs. Methuen & Co., Ltd., 36, Essex Street, W.C. 10s. 6d. net.

Die Atomic, von JEAN PERRIN, mit autorisation des Verfassers deutsch herausgegeben von DR. A. LOTTERMOSER. Pp. XX. + 213. 1923. *Verlag von Theodor Steinkopff, Residenzstrasse, 12b, Dresden, Blasewitz.* 5s.

New Patents.

THIS list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

26736—Bhopal Produce Trust, Ltd.—Recovery of oxolates, etc. Oct. 25.

26572—British Cellulose & Chemical Manufacturing Co., Ltd.—Treatment of cellulose acetate, etc. Oct. 24.

26526—Henshaw, S.—Production of neutral sulphate of ammonia. Oct. 24.

26680—Leigh, R.—Hampers for acid carboys, etc. Oct. 25.

Specifications Published this Week.

205224—Houseman, C. R., and British Oxygen Co., Ltd.—Manufacture of sulphur dioxide and apparatus for use therein.

Abstract Published this Week.

203352—Titanium oxide and sulphate.—Weizmann, C., and Blumenfeld, J., of 16, Addison Crescent, London.

Titanium sulphate and oxide; ferrous sulphate.—To obtain titanium compounds free from iron, an ore such as ilmenite is heated to 150-180° C. with sulphuric acid of 70-90 per cent. strength. The solid product is leached with a limited quantity of water in presence of a reducing agent, preferably spongy iron, most of the iron sulphate being left in the solid form. The water is added little by little at a temperature not above 50° C. The reduction is completed when a brown-violet coloration shows the presence of titanous salts. The solution is then treated to hydrolyze the titanium sulphate in any known way, and the first washings of the precipitated hydroxide are effected with water acidulated with sulphuric acid and containing a titanous salt so as to avoid any oxidation of ferrous salts which would injure the colour of the product. The precipitate is calcined under oxidizing conditions, for instance by blowing air through the container or through the material during calcination, or, according to the Provisional Specification, by calcining in the presence of sulphuric acid, the object being to prevent any reduction owing to organic matter that might be present. The ferrous sulphate left with the undissolved residue of the ore is recovered by solution and crystallization, and may be treated to recover the sulphuric acid. According to the Provisional Specification, the solution of titanium sulphate is protected from oxidation during hydrolysis by means of a film of oil, vaseline or the like.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

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THE CHEMICAL NEWS,

VOL. CXXVII. No. 3319.

THE INTERMITTENT GLOW OF PHOSPHORUS.

By K. R. Krishna Iyer.

The intermittent luminosity propagated in pulsatory fashion when the last traces of oxygen are being removed from air by means of phosphorus, or when air is allowed to leak slowly into an exhausted vessel containing phosphorus, was recently dealt with by the present Lord Rayleigh (*Proc. Roy. Soc.*, 1921 (A) XCIX., 372). He showed the importance of the presence of water vapour for the propagation of the luminons pulses, and also how the same phenomenon occurred in the presence of traces of substances known to inhibit the glow of phosphorus.

Working on this problem, I find that the intermittent luminosity and formation and propagation of luminous pulses could be obtained equally strikingly *in an open vessel* containing air, such as a test tube, flask, or tube open at both ends, if traces of these inhibitors—*e.g.*, naphthalene, carbon disulphide, turpentine, light petroleum—are present. The effect is particularly good if the vessels be wet with water. No intermittence or pulse-formation is observed with water alone. It is also found that the luminous pulses *creep along the surface* of the vessels.

It is well-known that the luminosity of phosphorus is inhibited in pure oxygen above a critical pressure (depending on the temperature), and that it becomes intermittent near the critical pressure.

The explanations offered for the periodic nature of the glow and its propagation in the presence of water and inhibitors (Rayleigh, *loc. cit.*; Joubert, *Ecole. Norm. Annales*, 1874, III., 209; Jorissen, *Chem. Weekblad*, 1918, XV., 705) have all been based on the view that here we are dealing with the propagation of combustion in an explosive mixture. The fact that exactly similar effects are produced, even in open vessels containing excess of air, and the clearly creeping nature of the propagation of the glow necessitate a modification of this view. It appears probable that the effect in oxygen at the critical pressure of inhibition and that observed in the presence of the "inhibitors" are both due to similar causes.

The luminosity of phosphorus, its inhibition, intermittent nature in presence of "inhibitors" and the formation and nature of propagation of the luminous pulses could all be strikingly shown as a lecture experiment by the following simple arrangement.

A very dilute solution of phosphorus in carbon disulphide is prepared and poured over a long narrow strip of filter paper or a cotton thread, suspended from an open glass tube inserted in a cork. The solvent is allowed to evaporate almost completely, so that fumes begin to appear on the strip. The cork is then loosely inserted into a conical flask of height greater than the length of the strip. Luminous pulses are seen to form and travel up and down along the strip. The formation of the pulses alternate with dark intervals. In the later stages the pulses travel along the sides of the flask also. If the strip happen to be permanently bright, a trace of carbon disulphide vapour introduced into the flask will start the above phenomena.

Chemistry Laboratory,
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THE MECHANISM UNDERLYING THE REACTION BETWEEN ETHYL CYANO-ACETATE AND TAUTOMERIC SUBSTANCES OF THE KETO-ENOL TYPE.

By R. F. Hunter, F.C.S.

The condensation of ethyl cyanoacetate with ketones has been the subject of many investigations. In this paper, however, we are only concerned with the recent work of Dr. C. K. Ingold, which was carried out at the Royal College of Science a year or two ago. Usually the first product which can be isolated is an unsaturated cyano ester, in which the double bond is situated either in the $\alpha\beta$ or $\beta\gamma$ position in respect to the carboxyl group. For instance, acetone yields the $\alpha\beta$ unsaturated condensation product, whilst cyclohexanone gives mainly a cyano ester in which the double bond occupies the $\beta\gamma$ position. The latter type of reaction appears to be the one most frequently met with, and it is possible to ascribe the production of cyano methylcrotonic ester from acetone to the instability of the unsaturated isomeride that is intermediate in

the reaction. In such cases a second molecule of ethyl cyano-acetate may enter into the reaction, the product being a derivative of glutaric acid. With regard to the primary condensation, there can be little doubt that it is the enolic modification of the ketone which enters into the reaction, because ketones such as benzophenone, of which no enolic modification can exist, fail to react, while others react in the proportion to their capacity for tautomeric change. Again, tautomeric ketonic esters, provided they are not sufficiently acidic to cause the dissociation of the sodium compound of ethyl cyanoacetate, readily react to give condensation products with this substance, but once the tautomeric character of the ketonic ester has been destroyed, say by alkylation, then the condensation can no longer be effected. Thus ethyl acetoacetate yields ethyl α-cyano β-methylglutaconate,

$$CO_2EtCH:CMe.OH + CHNa(CN)CO_2Et \rightarrow CO_2EtCH:CMeCNa(CN)CO_2Et + H_2O,$$

whilst ethyl dimethylacetoacetate shows no tendency to condense.

The problem was to discover wherein lay the cause of the reactivity of the enolic forms. Clearly there were two main possibilities. The equation given above suggested that the prime action consisted in the elimination of water through the union of the hydroxyl group of the enolised substance with the reactive hydrogen atom of the cyano ester. This view appeared to be the one accepted without any reason previous to Ingold's work. Now it is possible that the reactive feature of the enolic substance is not the hydroxyl group, but the *double bond*. The direct addition of sodium cyanoacetic ester would then be the initial reaction, the elimination of water being a subsequent occurrence. We can illustrate the view by:—

$$CO_2EtCH_2CMe(OH)CNa(CN)CO_2Et$$
$$\rightarrow CO_2Et.CH:CMeOH + CHNa(CN)CO_2Et$$
$$\rightarrow CO_2EtCH:CMeCNa(CN)CO_2Et + H_2O.$$

The decision might be arrived at by eliminating alternately the two possibilities. Thus it might be attempted to condense esters in which there is a double bond, but no hydroxyl group. In this case a reaction of the first type would be impossible. Secondly, it might be attempted to employ esters containing one hydroxyl group but no double bond. In this case the occurrence of the reaction of the second type would be eliminated. The evidence obtained by Ingold was strongly in favour of the second view, namely, that in all cases the unsaturated linking is responsible for the initial condensation, and the elimination of water is a subsequent effect. Nine hydroxy esters were examined. Glycollic ester, the simplest of all the esters examined alone, yielded no trace of condensation product with ethyl sodiocyanoacetate under conditions which gave positive results in all other cases. The reason being that glycollic ester is the only ester which cannot pass by the loss of water into an unsaturated compound. The three other hydroxy esters examined all gave abnormal condensation products, such as could only be derived by the direct addition of ethyl sodiocyanoacetate to the unsaturated compound, for example, 1 actic ester gave ethyl α cyanoglutarate, from which glutaric acid could be obtained by hydrolysis:

$$CH_3CH(OH)CO_2Et \rightarrow CH_2:CHCO_2Et \rightarrow$$
$$\begin{matrix} CH_2CH_2CO_2Et \\ | \\ CH(CN)CO_2Et \end{matrix} \rightarrow \begin{matrix} CH_2CH_2CO_2H \\ | \\ CH_2CO_2H \end{matrix}$$

Hydracetic ester, on condensation and hydrolysis, gave glutaric acid:

$$CH_2(OH)CH_2CO_2Et \rightarrow CH_2:CHCO_2Et \rightarrow$$
$$\begin{matrix} CH_2CH_2CO_2Et \\ | \\ CH_2(CN)CO_2Et \end{matrix} \rightarrow \begin{matrix} CH_2CH_2CO_2H \\ | \\ CH_2CO_2H \end{matrix}$$

The condensation of hydroxyglutaric ester afforded very direct evidence of the intermediate formation of unsaturated compounds in the reactions.

The Imperial College of Science and Technology, S.W.7.
September, 1923.

GENERAL NOTES.

GERMANY'S COMMERCE AND INDUSTRY DURING OCTOBER.

Mr. J. W. F. Thelwall, the Commercial Secretary at Berlin, has forwarded to the Department of Overseas Trade a review of Germany's trade and industry during October.

The decline in economic life which began to be accentuated in August was greatly intensified in October. The reason lies in the internal and, particularly, in the foreign political situation which was not relieved as had been hoped, by the abandonment of passive resistance in the Ruhr. Restriction

of work, dismissals of workmen, low wages and high prices which exceed the world's market level more and more, are characteristic of the low condition of economic life.

Mining.

The Upper Silesian pit-coal production was normal during the first three weeks of the month. On October 22 a strike broke out, and gradually extended to all mines, but work was reported to have been resumed on October 30.

In Central Germany conditions in the brown coal and potash mines were unfavourable. In all districts lack of sales was complained of. The curtailment of working hours, the dropping of shifts, dismissals, and the closing of one mine became necessary. Up to three shifts a week were dropped. In the Mansfeld copper schist mines the position became so bad that two shifts had to be dropped.

In the Berlin coal trade the introduction of gold mark invoicing caused great difficulties. Payments were considerably delayed. Delays occurred not only in local trade, but also, in particular, in the industry which, owing to declining employment and increased paper mark prices, was unable to effect prompt payment On the other hand, the pits press more and more for speedy payment in order that they may be ready to meet wage demands which increase almost daily.

Inland business in the Halberstadt potash industry was almost completely stagnant, in spite of the fact that prices were reduced during the course of the month. Foreign trade was better, but still quiet.

In the iron ore industry in the Siegesland and Dill districts, further mines were compelled to close down or to restrict operations considerably. Conditions in the mines where the work is exclusively underground were particularly unfavourable, as they had to bear the full cost of pumping the water even where the mines had been closed down.

Iron, Machinery, and Electro-Technical Industries.

The abandonment of passive resistance did not change the position in the Ruhr. As before, the pits and foundries were idle. Their position could scarcely be imagined more intolerable. Coal and coke supplies continued to be despatched by the French. The supplies of bye-products, such as ammonia, benzole, coal-tar, resin, raw naphthaline, etc., were completely cleared by the French.

In Upper Silesia, employment in the Oppeln pig iron and finished products works was still satisfactory. Orders, however, declined during the course of the month. Foreign trade was completely stagnant.

The electro-technical industry reported that prices for semi-manufactures were high and delivery periods short. The market is small and stagnant. Individual works report falling prices. Short-time work has been introduced on a fairly large scale.

Chemical Industry.

The business position was such that more workers had to be dismissed, and presumably a further restriction of operations is to be reckoned with in the Wiesbaden district.

India-Rubber Industry.

There was no improvement in the position of the Hanover india-rubber industry. The market possibilities at home have grown worse, so that a curtailment of working hours and further dismissals of workmen could not be avoided.

Timber Industry.

In the saw-mills and in the wood trade business was almost at a standstill. Only small transactions were concluded which served to fill up stocks. Business with England appeared to experience a slight revival.

Clothing Industry.

In the wool wholesale trade business, as before, could not be revived, as, owing to the large amount of unemployment in the textile industry, the demand remained very small. Wool prices were firm, and there was the less anticipation of a fall, as, in view of the fact that the wool shears have yielded only a small quantity of fine wool, an increased demand will be met by a small supply. Conditions also grew worse in the carded yarn spinning-mills. In occupied territory the demand was extremely small owing to the position of the cloth industry. Deliveries to districts on the right bank of the Rhine were out of the question, in view of the difficulties of transport and, above all, to the fact that the costs of production had far exceeded the world's market price.

In the Aix-la-Chapelle cloth industry, the stock of orders was extremely small. Practically no new orders were received. Foreign business was also almost at a standstill. The high costs of production have greatly impaired the power to compete on the

foreign market. In the cloth trade business was irregular, and was, in general, confined within narrow limits.

Leather Industry.

The prices for raw hides and skins of all kinds rose continually, both at the auctions and on the open market. A much larger turnover would have been obtained had not the dearth of money made itself exceptionally felt.

MEDICAL SUPPLIES FOR THE DUTCH GOVERNMENT.

MR. R. V. Laming, O.B.E., H.M. Commercial Secretary at The Hague, reports that the Dutch Government are calling for tenders, to be presented by November 27, for the supply of various medical supplies.

Applications from United Kingdom firms for further particulars should be addressed to the Department of Overseas Trade (Room 52), 35, Old Queen Street, London, S.W.1. (Reference No. 30953/F.W./C.C./(2).

REPORT ON THE CONSUMPTION OF PREPARED NON-METALLIC MINERALS IN CANADA.

An investigation has been made to determine the extent of the market in Canada for finely-ground non-metallic minerals, and this report on the consumption of certain non-metallic minerals in Canada has been prepared with a view to exploring the possibility of establishing plants in Canada for the production of finely-ground non-metallic commodities for home consumption. The consumption of these commodities in Canada is considerable in the aggregate, and comprises many different varieties. Heretofore, though extensive deposits of the crude material are known to exist in Canada and though these deposits are in certain cases being worked, the bulk of the supply has been derived from importations.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, NOVEMBER 15.

Papers read:—

SIR WILLIAM BRAGG, F.R.S., and PROF. G. T. MORGAN, F.R.S.: *Crystal Structure and Chemical Constitution of Basic Beryllium Acetate and Propionate.*

Basic beryllium acetate is shown by X-ray analysis to be a highly co-ordinated compound. The molecule is a perfect tetrahedron, having an oxygen at the centre, a beryllium alone at each corner and an acetyl group associated with each edge. The crystalline structure is the same as that of diamond. The propionate forms a monoclinic crystal. The propyl group can no longer be arranged so as to possess a plane of symmetry, as in the case of the acetyl; and in consequence the symmetry is much less.

L. C. JACKSON: *Investigations on Paramagnetism at Low Temperatures.* Communicated by Prof. H. Kamerlingh Onnes, For. Mem. R.S.

G. I. TAYLOR, F.R.S.: *Experiments on the Motion of Solid Bodies in Rotating Fluids.*

Part I. Powdered substances. The following paramagnetic substances have been investigated from atmospheric temperature down to lowest temperature obtainable with liquid hydrogen (about 14° K.): anhydrous sulphates, heptahydrated sulphates and ammonium double sulphates of cobalt, nickel and ferrous iron. New phenomena of considerable interest have been found at the lowest temperatures. Thus, whilst these substances follow the Weiss law $\chi (T + \Delta) = C$ at relatively high temperatures, the following types of deviation from this law were found at the lowest temperatures: (1) Susceptibility increases more rapidly with fall in temperature than is given by Weiss law. (2) The curve of $\frac{1}{\chi}$ against T possesses a point of inflection. (3) A maximum and a minimum value of susceptibility occur in region of lowest temperatures.

Part II. Crystals. The principal sus-

ceptibilities of crystals of cobalt ammonium sulphate and nickel sulphate (heptahydrate) have been determined over a temperature range of 290° K. down to 14° K. These are the only data yet available as regards the principal susceptibilities of crystals at very low temperatures. In both cases each of the principal susceptibilities follows the Weiss law at higher temperatures; but deviates therefrom at lower temperatures. The Curie constant C is same for each of principal susceptibilities of any crystal. Deviations from Weiss law in case of cobalt ammonium sulphate fall into category (1) above, while those of nickel sulphate fall into category (2).

An attempt is made to connect magnetic phenomena with the structure of crystals.

L. C. Jackson and Prof. H. Kamerlingh Onnes, For. Mem. R.S.: *The Magnetic Properties of some Paramagnetic Double Sulphates at Low Temperatures.*

In continuation of a previous investigation the magnetic susceptibilities of the following powdered substances have been measured over a range of temperatnre of from atmospheric temperature down to about 14° K.: cobalt potassium sulphate, cobalt rubidium sulphate, manganese ammonium sulphate. The results or the two cobalt compounds show that these substances follow the law χ (T+Δ) = const. at not too low temperatures, but deviate therefrom at the lowest temperatures, in such a way that susceptibility is *greater* than value calculated from the above law, thus confirming the results previously obtained with cobalt ammonium sulphate.

Contrary to first expectation, it was found that the Δ's of the three above-mentioned cobalt compounds were nearly equal. It is shown, however, that this result is indeed to be expected by a consideration of data already published for the principal susceptibilities of cobalt ammonium sulphate and the conclusions drawn by Tutton as to the structures of these monoclinic double sulphates from his well-known crystallographic investigations.

Manganese ammonium sulphate was found to obey the Curie law, χ T = const., down to the lowest temperature investigated. This result fits well with the known behaviour of other manganese salts, showing that in this series of compounds the substance follows Curie's law more closely the greater its "magnetic dilution."

H. H. Potter: *Some Experiments on the Proportionality of Mass and Weight.* Communicated by Prof. O. W. Richardson, F.R.S.

The gravitational accelerations of lead, steel, ammonium fluoride, bismuth, paraffin wax, duralumin and mahogany have been compared with that of brass, and no difference greater than that attributable to experimental error has been found. An accuracy of one part in 50,000 has been obtained. Special attention has been given to two substances, ammonium fluoride and paraffin wax, which have large hydrogen contents.

Papers read in title only:—

Lord Rayleigh, F.R.S.: *Further Studies on the Glow of Phosphorus and its Extinction by Moist Oxygen.*

The velocity of blast necessary to blow away the glow of phosphorus increases enormously with rise of temperature. On the other hand, it is enormously diminished by enriching the air blast with oxygen. In either case the range examined was of order 1,000 times. This velocity of blast measures rate of propagation upstream of glow through mixture of phosphorus vapour and oxygen.

Where velocity is reduced, by cooling or by adding oxygen, to less than 1 cm./sec., the condition of extinction is approached. From this viewpoint the known extinction by moist oxygen alone is seen to be the limiting case of slow propagation. It follows that extinction is due to failure of the process causing propagation. This was shown before to be in all probability a catalytic action of products of combustion. Excess oxygen, like other inhibiting substances, "poisons" these products or makes them unfit to act—perhaps by a process of condensation, similar to that which is found to clog the motions of ions in gaseous combustion.

Prof. H. A. Wilson, F.R.S.: *An Experiment on the Origin of the Earth's Magnetic Field.*

H. Robinson, D.Sc.: *The Secondary Corpuscular Rays produced by Homogeneous X-Rays.* Communicated by Sir Ernest Rutherford, F.R.S.

The original Robinson-Rawlinson method of investigating velocities of secondary cathode rays produced by X-rays has been developed with a view to increased accuracy. Special attention has been paid to homo-

geneity of the primary X-ray beam, and the effect of fluorescent radiations of the material under investigation has been thereby reduced.

The velocities of secondary electrons are measured by deflection in the magnetic field on a pair of large Helmholtz coils. The copper, $K\alpha$, rays are used as primary X radiation. This choice permits of measurements being made in regions already mapped out by X-ray spectroscopy, and also allows some of the less known parts of the spectrum to be investigated. Satisfactory agreement with existing data has been found in the former region.

It has been possible to separate and measure five of the N absorption edges of bismuth, the remaining two not being separated from the O rings. All five M edges have been measured for atoms as light as tungsten. The L limits have been measured as far as copper, and the K limits to oxygen. The very soft limits cannot at present be measured very accurately, but reasons are given for believing that K limits of light atoms may be higher than accepted values.

Intensities of lines of corpuscular spectra are estimated and discussed. Progressive changes are found to occur along the series of elements in relative intensities of different members of the same group.

Lt.-Col. J. W. Gifford (with an Introduction by Prof. T. M. Lowry, F.R.S.): *Some Refractive Indices of Benzene and Cyclohexane.* Communicated by Prof. T. M. Lowry, F.R.S.

J. A. V. Butler: *A Note on "The Significance of the Electrode Potential."* Communicated by Prof. J. W. McBain, F.R.S.

1.—A thermodynamical argument given in Heyrovsky's paper on The Significance of the Electrode Potential is examined, and it is shown that certain stages of the cyclic process employed are irreversible and that the conclusions are therefore erroneous.

2.—A method of conducting the cyclic process reversibly is given, and it is shown that the sum of the differences of potential round the cycle is zero; it follows that no information regarding the relations between the electrode potentials and the various chemical equilibrium constants is obtained crude use of a cyclic process of this kind.
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THE ROYAL SOCIETY.

Thursday, November 22.

Papers read:—

F. Simeon: *The Carbon Arc Spectrum in the Extreme Ultra-violet. II.* Communicated by Prof. A. W. Porter, F.R.S.

H. J. Gough and D. Hanson, D.Sc.: *The Behaviour of Metals subjected to Repeated Stresses.* Communicated by Sir Joseph Petavel, F.R.S.

W. Sucksmith and L. F. Bates: *On a Null Method of Measuring the Gyro-Magnetic Ratio.* Communicated by Prof. A. P. Chattock, F.R.S.

J. H. Shaxby: *Studies in Brownian Movement, II. The Determination of Avogadro's Number from Observations on Bacteria (Cocci).* Communicated by Prof. S. W. J. Smith, F.R.S.

Papers read in title only:—

H. Hartridge, Sc.D., and F. J. W. Roughton: *The Kinetics of Hæmoglobin, II.* Communicated by Prof. J. N. Langley, F.R.S.

A. F. A. Young: *The Thermionic and Photo-Electric Properties of the Electro-Positive Metals.* Communicated by Prof. O. W. Richardson, F.R.S.

O. F. T. Roberts: *The Theoretical Scattering of Smoke in a Turbulent Atmosphere.* Communicated by Dr. G. C. Simpson, F.R.S.

ROYAL INSTITUTION.

The 98th Course of Juvenile Lectures at the Royal Institution to be delivered this Christmas by Sir William Bragg, F.R.S., is entitled *Concerning the Nature of Things,* and will deal with I., *The Atoms of which Things are Made;* II., *The Nature of Gases;* III., *The Nature of Liquids;* IV., V., and VI., *The Nature of Crystals,* (a) *Diamond,* (b) *Ice and Snow,* (c) *Metals.*

The first lecture will be given on Thursday, Dec. 27, 1923, and the succeeding ones on Dec. 29, 1923, and Jan. 1, 3, 5, and 8, 1924.

THE CHEMICAL SOCIETY.

Papers read at the Ordinary Scientific Meeting, November 15:—

Ring-chain Tautomerism. Dynamical Evidence Relating to the Mutarotation of the Sugars, by J. W. BAKER, C. K. INGOLD, and J. F. THORPE.

An earlier paper on the mechanism of mutarotation, dealing not only with dynamical, but also with structural and other aspects of the problem, showed that the mutarotation-time curves have (*a*) a form; (*b*) a spacing, on the mutarotation-time-concentration diagram, which are entirely at variance with the dynamical consequences of the intermediate-hydrate theory, but are in complete agreement with the hypothesis of ring-chain tautomerism, to which structural evidence also points. It has been objected that the derivation of the dynamical consequences of the hydrate theory was based on a fallacy. The authors do not accept this, and now present the complete mathematical analysis on which their conclusions were based.

An X-Ray Investigation of certain Organic Esters, and other Long Chain Compounds, by G. SHEARER.

By means of an accurate X-ray reflexion method, measurements have been made upon solid crystalline films of methyl, ethyl, octyl, and cetyl palmitates, of methyl and ethyl stearates, of *p*-hexadecylphenol, *p*-octadecylphenol, and of octadecylbenzene. As in Müller's experiments on normal fatty acids, very good reflexions were obtained from what are probably the crystal cleavage-planes, the distances or "spacings" between which can thus be determined. The cleavage spacings of the palmitic esters increase regularly with the number of carbon atoms in the alkyl group; and the increment per carbon atom of the chemical formula is the same for these esters as for the two stearates studied, namely, 1.22 A.U. for each CH_2 of the *alkyl* radicle. When the palmitic and stearic esters of a given alkyl radicle are compared, the increment in spacing per CH_2 of the *acid* radicle is found to be 1.0. This figure agrees with Müller's value of 2.0 in the case of the free fatty acids, if his assumption is adopted that there are two molecules end-to-end between the cleavage planes of the free acids, and if only one be allowed in the cell of the esters. The accepted and independently measured "diameter" of the carbon atom is 1.5 A.U. In order that chains, built of atoms of this diameter, shall have the perpendicular distance of 1.22 A.U. between contiguous carbon atoms, which is shown to prevail in the alkyl chains, it is necessary, either that the chains shall be tilted at an angle to the cleavage planes, or else, if their lengths are perpendicular to the planes, that the carbon atoms should be linked spirally or zig-zag. It is possible to calculate the observed cleavage spacings from the molecular formulæ, placing one or else two molecules between successive cleavage planes as already indicated, by using the independently-known "atomic radii," and by allowing that an acid radicle increases by 1.0 A.U., an alkyl radicle by 1.22 A.U., per CH_2 group; where necessary, W. H. Bragg's value for the dimeusions of the benzene ring is also used.

Further X-Ray Measurements of Long Chain Compounds, and a Note on their Interpretation, by ALEX. MULLER and G. SHEARER.

Data were given for the cleavage spacings of undecylic, pentadecylic, and margaric acids; for oleic, elaidic, and *iso*-oleic acids; and for erucic and brassidic acids.

A systematic exposition was given of the conclusions which can legitimately be drawn from these experiments. In the case of stereoisomers of a given unsaturated acid, the observed differences, when expressed in terms of the two types of chain, lead to the inference of cis-trans isomerism, and point to a definite attribution of structure as between the two isomers. The differences between corresponding saturated and unsaturated "straight-chain" acids were discussed.

The Constitution of the Disaccharides. Part IX.: Gentiobiose: Its identity with Amygdalin Biose, by W. N. HAWORTH and B. WYLAM.

On hydrolysis of completely methylated gentiobiose, 2.3.5.6-tetramethylglucose and 2.3.5-trimethylglucose were obtained. Gentiobiose thus possesses the same constitution as both maltose and amygdalin biose, and since the latter sugar contains a β-linking uniting the two glucose residues exactly as does gentiobiose, this is the disaccharide which occurs in amygdalin. Synthetic work also confirmed this result.

The Constitution of Raffinose, by W. N. HAWORTH, E. L. HIRST and D. A. RUELL.

Raffinose, prepared from cotton seed meal, gave rise on methylation to hendecamethyl raffinose, b.p. 238° C. /0.02 mm., $[\alpha]_d = + 128°$. Hydrolysis with 1 per cent. hydrochloric acid led to the isolation of three partly methylated hexoses, tetramethyl γ-fructose identical with that isolated from methylated sucrose, 2.3.5-trimethyl glucose (butylene oxidic), which gave a crystalline methylglucoside melting at 94° C., and a tetramethyl galactose, which gave a crystalline anilide identical with that prepared from methylated lactose. A structural formula was raffinose was deduced.

It appears that the constitution of melibiose is to be represeuted by a formula in which the glucose unit, through the hydroxyl group attached to its terminal carbon atom 6, is linked with the reducing group of galactose.

THE FARADAY SOCIETY.

(Concluded from last week.)

Papers read at the meeting on November 12:—

The Effect of Sucrose on the Rate of Coagulation of a Colloid by an Electrolyte, by LEONARD ANDERSON, PH.D.

The concept that the activity of ions, rather than their concentration, was likely to play an important part in chemical kinetics was first suggested by Harned. The interesting problem arises as to whether the activity of the added electrolyte ions does or does not play the significant roll in a typical *colloidal* phenomenon, namely the rate of coagulation of a colloid in presence of added electrolyte.

The work of Moran and of Corran has shown that sucrose possesses the property of causing a large increase in the activity of various ions whilst not appreciably altering their concentration. It was, therefore, considered of interest to investigate the influence of sucrose on the coagulation of a typical colloid, gold hydrosol. In colloid systems the Smoluchowski[1] equation is the only one, possessing a strictly theoretical basis, which deals with the kinetics of coagulation. From the work of Anderson and of other investigators,[2] however, this equation appears to be limited to rapid coagulation. In the present instance, a slow or moderately rapid rate of coagulation was considered best, since, in this region, the rate of coagulation is very sensitive to slight variations in the concentration of the coagulant. In view of the inapplicability of the Smoluchowski equation to this region, a more arbitrary method of measuring the rate of coagulation was chosen, namely, the time required for the originally red gold sol to reach the tint of a partially coagulated gold sol, stabilised by addition of gelatin.

From the literature it appears to be uncertain whether sucrose does or does not behave as a peptiser towards colloidal sols. Bancroft enumerates certain cases in which sucrose does peptise. Chatterji and Dhar, however, state that true peptisation by sucrose is doubtful. The addition of sucrose to the colloid system increases the viscosity and should thereby lower the speed of coagulation. The sucrose, however, besides affecting the mobility of the colloidal particles also affects the mobility of the coagulating ions.

The experiments indicated that the sucrose had a two-fold action. The first was a definite peptising effect, and the secon an accelerating effect, upon the coagulatio of colloidal gold by certain electrolytes. I the case of potassium chloride as electrolyt the peptising action was most marked an rapidly increased as the sucrose increase In the case of barium chloride, in presen of sucrose, the coagulation proceeded mo rapidly (above 10 per cent. sucrose) than should do on the basis that activity is t sole factor determining the rate of coagul tion. From this it would appear that t sucrose, in addition to its peptising effec also introduced a specific augmentation coagulation in excess of what would be a ticipated. The latter effect is appasent least in the case of potassium chloride a greatest in the case of barium chloride.

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[1] Smoluchowski, *Zeitschr. physikal* XCII., 129, 1917.

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[2] *Anderson (Trans. Faraday Soc.). Kru and Arkel, Rec. Trav. Chim. Pays-Ba* XXXIX., 656, 1920. *Westgren and Re stotter, Zeitschr. physikal Chem.*, XCI 750, 1917. *Mukherjee and Papaconstan nou, Phil. Mag.*, XLIV., 305, 1922.

the case of hydrogen ion the value of $\frac{T}{\eta}$ is constant above 10 per cent. sucrose which may indicate that the peptising effect of the sucrose was just counterbalanced by the specific augmenting effect and consequently in the case of HCl the true activity apparently showed itself.

Sucrose of itself had no apparent coagulating power on gold sol. As regards the augmentation of the coagulating efficiency of ions produced by the sucrose it might be suggested that possibly the effect was due to the alteration in the dielectric capacity of the medium as a result of the increase in the sugar content. Measurements of the dielectric capacity of sugar solutions indicated a marked fall as compared with that of water. The electrical adsorption of the ions would therefore be intensified, involving an increase in neutralising efficiency on the electrical charge of the colloid particles, with a consequent increase in the rate of effective collisions, *i.e.*, effective in respect of coagulation, on the part of the colloid particles. If this is the case the horizontal line obtained in the case of hydrogen ion was largely accidental, and the results can only be regarded as qualitative evidence in favour of the activity of ions as a significant factor for coagulation.

It was established from the experimental evideuce that in the coagulation of gold sols by hydrochloric acid, barium chloride and potassium chloride in presence of varying amounts of sucrose at 25° C, when the concentration of the hydrogen ion was maintained constant, the time of coagulation, corrected for viscosity, was found to pass through a maximum at ahout 10 per cent. sucrose.

When the activity of the H ion was maintained constant, the time of coagulation corrected for viscosity rose until 10 per cent. sucrose was reached and then became constant

In the case of barium chloride, the same conditions were observed, and in both cases the value of $\frac{T}{\eta}$ passed through a maximum at about 10 per cent. sucrose.

In the case of potassium chloride the concentratiou of the potassium ion was maintained constant. It was found, contrary to anticipation, that $\frac{T}{\eta}$ increased continuously as the sucrose content increased.

Sucrose *exerts a definite peptising effect* upon colloidal gold, and it also exerts a specific augmentation of coagulation in the case of hydrogen and barium ions over and above that of increasng the activity of these two ions. It is thus evident that sucrose is by no means inert towards ions and gold sols. It exhibits apparent antagonistic action.

The experiments indicated in general, however, that the coagulating power of an ion is dependent upon its activity rather than upon its concentration, a conclusion which brings the typical colloid phenomenon of coagulation into line with the kinetics of chemical change in homogenous (molecular) systems.

A Method of Measuring the Rate of Coagulation of Colloidal Solutions over Wide Ranges, by H. H. Paine, M.A., B.Sc., and G. T. R. Evans, B.Sc., University of the Witwatersrand, Johannesburg.

Considerable light was thrown on the kinetics of coagulation some few years ago in papers by Smoluchowski, and by Freundlich. These writers considered a colloidal solution from the point of view of the kinetic theory. Coagulation is regarded as the "coalescence" of "molecular" particles resulting from their mutual collision.

Smoluchowski was concerned primarily with coagulation when it occurs at its maximum rate—that is, when all collisions between colloidal particles result in coalescence. The existence of this maximum is demonstrated by Zsigmondy with gold sol, and by Kruyt and van Arkel with selenium sol. When successive samples of the colloidal solution were treated with increasing amounts of an electrolyte, the rates of coagulation increased to a *maximum* or *limiting*, value.

Freundlich extended the theory to slow coagulations, and made a further inquiry into the forces between the particles. His theory states that in the case of a stable colloidal solution, the collisions between particles are "elastic," *i.e.*, they do not result in coalescence. A repulsion (something which prevents coalescence) exists between two particles arising from the existence of the electrical double layer. As soon as the potential difference across this double

layer is reduced beyond a certain critical value, the repelling force vanishes, and a collision results in coalescence. This critical point has, then, many of the properties originally assigned to the isoelectric point.

It occurred to us that the work could be extended by the use of a "protective colloid." The addition of gelatine or starch results in making the colloid less sensitive to electrolytes, *e.g.*, Lucrs showed that the time taken for a change to be observed in a Congo ruby sol on the addition of an electrolyte is increased if gelatine is present.

Coagulations which normally proceed rapidly, can be retarded until the methods for studying relatively slow coagulations can be applied. We have observed coagulation proceeding at its "limiting rate" for a colloidal copper solution to which a suitable quantity of starch had been added.

The rate of coagulation of colloidal copper solutions was studied for a wide range of electrolyte concentrations by making use of the retarding effect of starch. Very rapid coagulations can thus be brought into the region of observation by ordinary methods. A "Transformation Factor" can be obtained which enables us to calculate what the rate rate of coagulation would have been for the pure colloid.

The results of these experiments agree closely with the equation deduced by Freundlich for the variation of the rate of coagulation with the concentration of the electrolyte. In particular, they confirm the existence of a maximum rate of coagulation.

Concentrations of starch below a certain minimum do not influence the rate of coagulation. If we express this influence by the "transformation factors," a linear relation holds between the logarithm of the transformation factor and the concentration of the starch over and above some minimum value.

Studies in Heterogeneous Equilibria.— Part I.: *Conditions at the Boundary Surface of Crystalline Solids and Liquids, and the Application of Statistical Mechanics*, by J. A. V. Butler, M.Sc.

Equilibrium between two phases occurs kinetically when equal numbers of molecules of every species concerned pass the boundary surface in both directions in the same time. The methods of statistical mechanics have been applied to the development of the kinetics of such processes only in the simplest cases.

Langmuir, whose pioneer work has inspired most of the recent progress in this direction, was concerned with vaporisation and the kinetics of gas reactions at solid surfaces. Rideal and Rodebush have employed special forms of the statistical equations with some success in the calculation of the constants of vaporisation. Langmuir's treatment has been extended to give a kinetic theory of the adsorption of gases by Henry. A tentative attempt to apply statistical equations to the calculation of solubiliy is mentioned by Dushman.

The subject is here approached from a somewhat different point of view, which may perhaps be made clearer by analogy. In the study of homogeneous equilibrium the law of mass action proved a reliable guide and inspiration for many years, although it gave merely the form of the equilibrium equation and did not lead to the calculation of the equilibrium constant in any case. The earlier workers on heterogeneous equilibrium approached the subject from the point of view of the law of mass action, but the results were comparatively meagre. Certain analogies with mass action obviously exist, but the backward state of our knowledge of the kinetics of phase equilibria may be traced to the fact that no general kinetic law of surface action has been available to replace the law of mass action.

The author showed that although it is no yet possible by the application of statistica methods to calculate the values of the equi librium constants, nevertheless thes methods can be used to co-ordinate divers cases of heterogeneous equilibrium, in par ticular solubility, the solubility product, th electromotive equilibria of metals and ox dation potentials.

Although this treatment does not ai primarily at the calculation of equilibriu constants and may have a very distinct us fulness if it is at present unable to achie that objective, it is evident that every o portunity should be taken of making a com parison with numerical data. In these com plex cases the exact calculation of equi brium constants is only likely to be achiev when the special conditions of each ca have been qualitatively explored.

The present paper was devoted to a pr liminary discussion of the conditions at t boundary surfaces between crystalline soli and liquids from this standpoint and t deduction of appropriate statistical con tions.

The extension of the methods to the s

cial case of metals dipping into their salt solutions, taking into account the electric factors concerned, have led to a physical interpretation of Nernst's electrolytic solution tension. A further extension provided a reasonable explanation of the mechanism whereby reversible oxidation potentials are set up at inert electrodes.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Paper read at the Royal Society of Arts on Tuesday, November 13:—

Galician-Canadian Pole Tool Fishing Methods, by ALBERT MILLAR, A.M.I.-MECH.E. (Member).

"Fishing" in oil well nomenclature covers a great variety of work, and does not merely represent the recovery of lost tools as is often thought to be the case. Side-tracking of tools or casing also come under the heading of "Fishing."

In all these operations "touch" plays a most important part, and this sense can only be acquired by long practice, as can also the knack of constructing suitable fishing tools to suit individual cases.

The author dealt very exhaustively with all the aspects of the problems involved in recovering lost tools, and in dislodging those that became stuck. The methods to be adopted, it was pointed out, differed according to the circumstances, from the case of slightly bent tools to a troublesome accident due to runaway tools or casing.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

A joint meeting with the Societe des Ingenieurs Civils de France (British Section) was held on Thursday, November 22. A paper entitled *The Electrification of the Midi Railway* was read by MONSIEUR A. BACHELLERY.

The Wireless Section held a meeting on Wednesday, November 21. Papers entitled *Periodic Trigger Reception*, by MR. E. V. APPLETON, M.A., D.Sc., and F. S. THOMPSON, B.A. (Royal Corps of Signals), and *A Dynamic Model of a Valve and Oscillating Circuit*, by MR. R. C. CLINKER, M.I.E.E., were read.

The joint meeting with the Societe des Ingenieurs Civils de France (British Section), which was to have been held on Thursday, November 15, was postponed to Thursday, November 22, at 6 p.m., when MONSIEUR A. BACHELLERY read his paper on *The Electrification of the Midi Railway.*

JOINT MEETING WITH THE PHYSICAL SOCIETY OF LONDON, THURSDAY, NOVEMBER 29, 1923.

The above meeting will begin at 5.30 p.m. (light refreshments at 5 p.m.), and will be in two sessions, viz.: 5.30 to 7 p.m., and 8 to 9.30 p.m.

The subject to be discussed will be: *Loud Speakers for Wireless and other Purposes*, and among those who will contribute short papers (including in some cases practical demonstrations) will be the following:—

Mr. S. G. Brown, F.R.S.; Captain P. P. Eckersley; Professor, C. L. Fortescue, M.A.; Professor J. T. MacGregor-Morris; Professor E. Mallett, M.Sc. (Eng.); Mr. L. C. Pocock, B.Sc.; Mr. H. L. Porter, B.Sc.; Professor A. O. Rankine, D.Sc., F.R.S.; Mr. E. K. Sandeman, B.Sc.; Mr. G. A. Sutherland, M.A.

By kind permission of the British Broadcasting Company arrangements are being made for parties, limited to 20 in number, to visit the Company's studio at No. 2, Savoy Hill, at half-hourly intervals from 3 to 5 p.m. Members wishing to visit the studio are requested to send their names to the Secretary, and to indicate the time which would be most convenient to them.

THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

The proceedings at the Monthly Council, held on November 7, Lieut.-Col. E. W. Stanyforth (President) in the chair, included the presentation of various reports. The following is the chemical report:—

Mr. J. L. Luddington (Chairman) reported that a letter had been received from the Departmental Committee on the Fertilisers and Feeding Stuffs Act, inviting evidence from the Society. Arrangements had been made for the Chairman to give evidence on behalf of the Society. Several points arising on a memorandum received from the Ministry of Agriculture had been considered by the Committee, who had instructed their representative as to the action to be taken thereon.

The Committee recommended that a re-

port by the Consulting Chemist, including the names of the vendors of the materials mentioned, be published as a private and confidential document to Governors and Members.

A draft of a proposed new by-law defining the duties of the Committee had been read and approved.

THE ROYAL MICROSCOPICAL SOCIETY.

President: Professor Frederic J. Cheshire, C.B.E., F.Inst.P.

Hon. Secretaries: Joseph E. Barnard, F.Inst.P., James A. Murray, M.D.

A meeting of the Society was held on November 21. The following papers were read and discussed:—

Sex-Reversal and Intersexuality, by MR. F. ROGERS BRAMBELL, B.A., B.Sc.

Further Evidence on the Transition of Peritoneal Cells into Germ-Cells in Amphibia, by PROF. J. BRONTE GATENBY, M.A., D.PH., M.R.I.A., F.R.M.S.

The Preparation of Eel Scales for Microscopic Examination, by DR. MILES JOHNSTON, M.B., CH.B.

The Microscope in Physics, by MR. F. I. G. RAWLINS, M.R.I., F.R.M.S.

DR. H. M. WOODCOCK (Lister Institute of Preventive Medicine) exhibited Bacteriomorphic Granules (or Granules simulating Bacteria) resulting from Cell-lysis or Digestion.

The section of the Royal Microscopical Society formed to deal with the Industrial Applications of the Microscope, and to assist in the development of Industrial Research in British Industries, will hold its next meeting at 20, Hanover Square, W.1, on Wednesday, November 28, 1923, at 6.30. The following exhibits have been arranged:

Mr. Conrad Beck, C.B.E., F.R.M.S.: A New Projection Microscope for measuring Fine Wires and Fabrics to $\frac{1}{50000}$ inch.

ve. Messrs. Adam Hilger, Ltd.: Dr. Müller's only ... X-Ray Spectrograph for the Examination of Sub-Microscopic Crystalline Structures.

Mr. J. E. Barnard, F.Inst.P., F.R.M.S., will give a Lecture Demonstration: The characteristics of a microscope for general and special purposes; the tests for mechanical efficiency that should be satisfied.

DR. SIDNEY H. BROWNING, L.R.C.P., M.R.C.S., F.R.M.S., will read a paper entitled *The Application of the Microscope to Industrial Diseases*.

MR. CHARLES A. NEWTON, F.R.M.S., will also read a paper entitled *The Microscope in the Examination of Condensed Milk*.

THE SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society of Glass Technology was held in the Lecture Room of the Department of Coal Gas and Fuel Industries, The University, Leeds, on Wednesday, November 21.

The following papers were received and discussed:—

Note on the Influence of Rapid Chilling on the Reversible Expansion of Clay, by H. S. HOULDSWORTH, M.Sc.

Glasshouse Pots: Some Notes on their Manufacture and Use, by P. MARSON.

The Casting Process for Glasshouse Refractories in German Glass Plants, by PROF. KURD ENDELL, DR.PHIL.

By the courtesy of the Directors and H. J. C. Johnstone, Esq. (General Manager), a visit was made to the Wortley works of Messrs. Leeds Fireclay Co., Ltd., Wortley, Leeds, on November 21. At the works members had an opportunity of inspecting pot clay blocks, firebricks, blast furnace linings, coke oven bricks, and drain pipes.

THE MINERALOGICAL SOCIETY

ANNIVERSARY MEETING, NOVEMBER 6

Dr. A. Hutchinson, F.R.S., President in the chair.

Papers read:—

DR. L. J. SPENCER, *Euclase and Platinum from Diamond-washings in British Guiana.*

Small discs resembling fossil corals consist of a radial aggregation of euclase crystals so arranged that the plane of symmetry is always parallel to the surface of the disc. These, together with tourmaline, diamond, gold, and platinum, were found in the conglomerates near the Kaieteur Falls on the Potaro River. Platinum has not hitherto been recorded from British Guiana.

HAROLD E. BUCKLEY, *Some Anomalous Optical Properties of Freshly-prepared mixed Crystals of the Seignette Salts.*

In the orthorhombic and isomorphous Seignette salts the sodium-potassium tartrate has the optic axial plane parallel to the brachy-pinacoid, whilst in the sodium-ammonium salt it is parallel to the macro-pinacoid. Mixed crystals of the two salts show, as would be expected, the optic axes for different colours in two planes at right angles (as in brookite), but only after the crystals have been prepared for some time. Freshly-prepared mixed crystals exhibit crossed dispersion of the monoclinic type (as in borax). A maximum angle of 75° between the axial planes for red and violet light is given by crystals containing 45° per cent. Na-K tartrate. On standing, the axial planes slowly migrate to the planes of symmetry, and equilibrium is established in from two to thirteen weeks, this being hastened by increasing the temperature.

COLONEL N. T. BELAIEW, *On the Genesis of Widmanstätten Structure in Meteorites and in Terrestrial Alloys.*

The Widmanstätten structure belongs to the triad of secondary structures, the other two being the structure of large crystals and the network structure. Under suitable conditions either of these structures may occur in iron-carbon alloys, or in any other alloys crystallising in the face-centred cubic lattice and exhibiting the same kind of equilibrium diagram. As the diagram of the Fe-Ni alloys is quite similar to that of Fe-C, the same kind of crystallisation may be expected in either case and also in that of meteorites. The well-known Widmanstätten figures in meteorites are also arranged in a Widmanstätten structure. From their appearance an inference can be made as to the conditions of cooling which furthered their appearance. These conditions are a very slow cooling after solidification in the granulation zone and a relatively rapid separation of the constituents afterwards in the zone of secondary crystallisation leading to their lodging themselves parallel to the octahedral planes in every granula.

PROF. L. R. WILBERFORCE, *Illustration and detection of inclined and horizontal dispersion in Bi-Axial Crystals.*

If the optic picture of an ordinary bi-axial crystal is viewed through a prism whose refracting edge is parallel or perpendicular to the axial plane, the appearances characteristic of horizontal and inclined dispersion are respectively produced. Such dispersions in a crystal, if too small to be detected by direct observation, can be discovered by thus using a prism of small angle alternately to reinforce and oppose them, and noting the want of symmetry in the effects produced.

ARTHUR RUSSELL, *On the occurrence of the Rare Mineral Nadorite in Cornwall, and of Beraunite (Eleonorite) in Co. Cork, Ireland.*

A single specimen of the rare mineral nadorite was found by the writer at the small antimony mine Bodannon, St. Endellion, Cornwall. The nadorite forms aggregates of nearly square platy crystals, transparent, of a yellowish-brown to reddish-brown colour, occupying a cavity in fibrous jamesonite. The crystals are combinations of a (100) and r (130), and are twinned on l (011). A very well-defined specimen of the variety of beraunite known as eleonorite was found by the writer at the iron and manganese mine of Roury Glen, Glandore, Co. Cork. It consists of a mass of diverging fibrous crystals of a reddish-brown colour, between walls of limonite. The fibres are elongated in the direction of the b axis, and show very strong pleochroism.

A. F. HALLIMOND and F. R. ENNOS, *On Stilpnomelane from North Wales*

A dark scaly vein-mineral, strongly resembling biotite, proves on analysis to contain very little potash, and is very similar in physical properties to stilpnomelane from Moravia. The composition agrees with the formula: $6SiO_2.2Fe_2O_3.2FeO.3H_2O$. Sp. G. 2.85. Apparently uniaxial; o = 1.687, e = 1.595. Pleochroic, o = dark brown, e = pale yellow. Brittle, with eminent basal cleavage and marked cleavage normal to this, yielding pleochroic chips. H = 3.5. Insoluble in hot N/2 HCl.

Dr. G. T. Prior, *On the Chemical Composition of the Ashdon Meteorite.*

This meteoric stone, which fell at Ashdon, near Saffron Walden, Essex, on March 9. 1923, is a white hypersthene-chondrite containing 8¼ per cent. of nickeliferous iron in which the ratio of iron to nickel is about 6.

CORRESPONDENCE.

THE COLOURING OF POISONS.

To the Editors of The Chemical News.

Sirs,—In a recent communication, under the above heading, Mr. James Sexton, M.P., advocates the colouring of poisons, and mentions several points against it put forward by the General Medical Council. He winds up with the words, " These four objections may be just or they may not. What I submit is that they are matters of policy to be determined by Parliament in open debate rather than settled autocratically by the most conservative of our trade unions."

Mr. Sexton has left out the most important people concerned in this matter. I refer to — I was going to have said "the *chemists*"—but to a *Member of Parliament* or one of the legal profession this word would, according to law, designate a pharmacist, who keeps open shop: it would, of course, include him, but I mean it in the wider sense of the " chemical profession." If Mr. Sexton does not know what I mean I shall be happy to explain it privately to him, if he so wishes.

I say he has left out the chemical profession; those men, or the followers of those men, who have discovered or synthesised the greater number of the poisons. Our contention is that if one poison is to be coloured, others will follow, and where is it to end? Mr. Sexton uses the expression "deadly poison"; what does he mean by that? He mentions one alkaloid, viz., strychnine; is this class of substance the one he calls " deadly poison," or would he also include prussic acid and the cyanides, compounds of arsenic including organic ones, mercurous and mercuric chlorides, lead acetate, phosphorus, etc.? Many of these are quite as poisonous as strychnine. If these are included, then try and imagine carrying on in a chemical laboratory with the KCN solution coloured with, say, gentian violet, and the $HgCl_2$ solution with malachite green. The alkaloids are detected chiefly by means of colour reactions, with which a colouring matter might seriously interfere, especially where students are concerned.

Parliament is notoriously unscientific, otherwise it would not have permitted *for one day* the importation of cotton into Germany during the war; therefore with all due respect to it, Parliament is not able to give a properly considered decision upon this matter, without first taking council with the chemical profession.

In the event of this matter becoming the law of the land, Mr. Sexton will be doing *his bit towards the advancement of science,* if he will do his best to have a clause inserted in the Act, permitting all chemical and other scientific laboratories, whether public or private, and those firms which supply them, to obtain, easily and without red tape, any *uncoloured* chemical, whether poisonous or not. We are put to no end of trouble, as things are, to obtain a little duty free absolute alcohol for use in unpaid research work, the expense of the latter falling upon the person doing the research, but which the Inland Revenue calls "a hobby" and refuses to allow the deduction of the income tax on such expense.

I mention these things to show how we are hampered in ways that were not intended by Parliament, and we wish to avoid, if possible, this further and probably more serious difficulty.—Yours, &c.,

Herbert Henstock, M.Sc., Ph.D., F.I.C.

Chemical Research Laboratory,
School Gardens,
Shrewsbury.

NOTICES OF BOOKS.

The Expert Witness, by C. A. Mitchell, M.A., F.I.C. Pp. XV. + 198. Cambridge: Messrs. Heffer & Sons, Ltd. 1923. 7s. 6d. net.

Chemists are very apt to engross themselves in their subject, and to leave to mere chance the important task of bringing to it and them a proper recognition of the high order of their work.

It is therefore only in times of great stress that such recognition is forthcoming, and by their own attitude chemists have themselves to thank for this.

In his latest work on the applications of science (and of art) to human identifica-

tion, criminal and other investigations, and to history, Mr. Mitchell has done his fellow workers a good service. This book is intended as much for the general public as for the scientific reader. It is eminently entertaining and interesting, and the reviewer's regret was on reaching the last page.

Expert evidence in general is discussed, and then the author deals with such specialised cases as the identification by skin-prints, medical, scientific and bacteriological evidence. The role of the expert in handwriting and in art, and the applications of such specialised evidence, is very ably described, with the aid of many illustrations.

The application of chemical knowledge in the investigation of documents and writings has hitherto not received adequate attention. The author directs attention to a number of recent investigations in legal cases where such chemical evidence was invaluable.

Doubtless these will become more and more numerous when it is more widely realised what a valuable part chemistry can play in such matters. J.G.F.D.

Landscape and History, 1s. London: Simpkin, Marshall, Hamilton, Kent & Co., Ltd.

The anonymous author has addressed this little volume more especially to the readers (and distinguished writers) of the various *Outlines* now appearing.

He makes apposite quotations from Mr. H. G. Wells' address before the British Science Guild last year, and his theme is apparently to draw attention to the geological and historical importance of veins and strata of iron. These, it is urged, possess very great significance to an extent by no means fully realised in scientific circles. Six excellent photographs are included.

The Institute of Science and Industry of Australia has issued Bulletin No. 24, entitled *The Production of Liquid Fuels from Oil Shale and Coal in Australia*, by R. E. Thwaites, M.A.

It is pointed out that the rapid depletion of the world stocks of petroleum and the extraordinary increase in the use of oil-fuels, and the advancing efficiency of oil-engines have awakened a recognition of the importance of all questions touching the economic production of liquid fuels. The necessity of the direct value of researches into their production is universally recognised. In Australia the question whether natural petroleum exists in payable quantities or not is unsettled, but large supplies of coals and shales certainly exist.

Apart from their direct economic value, they have also that which arises from the possibility of making the country independent of foreign supplies.

The present Bulletin embodies the results of the inquiries made. For some years past Mr. Thwaites has made a special study of fuel problems, and has also carried out experimental investigations on the distillation of coal and the production of liquid fuels therefrom, both in small and large scale plant.

The Ministry of Agriculture and Fisheries has issued a leaflet, No. 316, dealing with the cultivation of lavender for marketing and distilling. Lavender has been grown commercially in the south of England for a great many years, having been introduced in 1568, and where the soil and situation are favourable, there is no doubt that it is a profitable crop and worthy of consideration. It is grown for the oil for perfumery, for sale in a fresh state as "bunched lavender," and as "dried lavender" for sachet making, etc. As regards oil production, it is pointed out that chemistry has not yet succeeded in producing a synthetic product which can claim to be a substitute for English oil of lavender, and hence the supply depends wholly upon the natural product.

BOOKS RECEIVED.

The Chemical Elements, by F. H. Loring. Pp. VIII. + 171. 1923. Messrs. Methuen & Co., Ltd., 36, Essex Street, W.C. 8s. 6d. net.

Konduktometrische Titrationen, von Dr. I. M. Kolthoff. Pp. VI. + 94. 1923. Verlag von Theodor Steinkopff, Residenzstr. 12b, Dresden, Blasewitz. 2s. 9d.

The Development of the Sciences, by Ernest Witham Brown, Henry Andrews Bumstead, John Johnston, Frank Schlesinger, Herbert Ernest Gregory, Lorande Lose Woodruff. Pp. XIV. + 327. 1923. Humphrey Milford, Oxford University Press, Amen Corner, E.C.4. 16s. net.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry, by J. W. Mel-

LOR, D.Sc. Pp. X. + 1074. Vol. IV., 1923. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 63s. net.

Elektrochemie Nichtwässriger Lösungen, von PAUL WALDEN. Pp. XI. + 515. 1924. Herr Johann Ambrosius Barth, Dorrienstrasse 16, Leipzig, Germany. Bound 28s., unbound 24s.

Organische Chemie, von DR. RUDOLF PUMMERER. Pp. XI. + 209. 1923. Verlag von Theodor Steinkopff, Residenzstr., 12b, Dresden und Leipzig. 4s.

New Patents.

THIS list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent *Agents, of 5, Chancery Lane, London, from whom* all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

27376—Albert, A.—*Process for producing organic* compounds of mercury. Oct. 31.

27233—Cassella & Co., Ges. L.—Production of acridinium compounds. Oct. 30.

27048—Chance & Hunt, Ltd.—Treating crude oxide and carbonate of zinc. Oct. 29.

27219—*Farbwerke vorm. Meister, Lucius & Bruning.*—Manufacture of acid azo-dyestuffs. Oct. 30.

Specifications Published this Week.

205141—Robinson, C. S.—Recovery and refining of sulphur.

205288—Goodwin, C. J.—Manufacture of oxides of nitrogen and nitric acid.

205301—Weymann, G.—Drying of ammonium sulphate.

197315—Compagnie de Bethune Soc. Anon.—Manufacture of ethyl alcohol from sulphovinic acid.

205528—Machay, H. S.—Method of and means for roasting metallic ores.

205563—Chemische Fabrik Greisheim Elektron.—Process for the production of aluminium chloride and alumina.

191363—Pereira, H.—Process for manufacturing dioxyperylene.

194719—Consortium fur Elektrochemische Industrie Ges.—Manufacture of anhydrides of fatty acids of low molecular weight.

Abstract Published this Week.

203749—Sodium silicate.—Clayton, W., of Aiderry, Allerton Drive, Mossley Hill, Liverpool, and Richards, H. W., of 9, Hawarden Avenue, Wallasey, Cheshire.

Sodium silicate solution is evaporated by spraying into heated air. The solution may be of 100° Tw. and may contain 2.1 parts by weight of silica to 1 part by weight of Na_2O. *The spraying may* be effected with the liquid at 45° C. by means of an air pressure of 65 lb. per sq. in. Beneath the jet *of liquid is a high velocity air jet at right angles* to the liquid jet as in milk spraying, a pressure of 150 lb. per sq. in. being suitable. Instead of an air jet superheated steam or flue gases may be used.

Messrs. Rayner Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d.

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THE CHEMICAL NEWS,

VOL. CXXVII. No. 3320.

ARE THE NATURAL GROUPINGS OF THE ELEMENTS AND THE SPECTRAL LINES OF HYDROGEN RELATED?

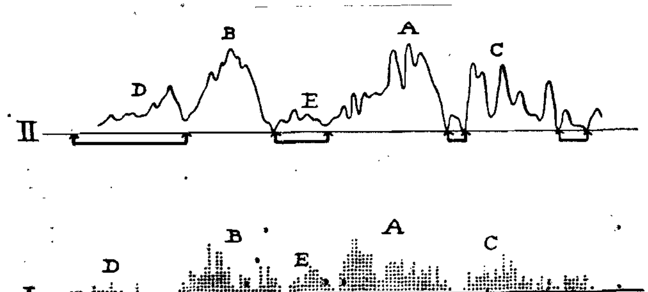
PART IV.*

BY F. H. LORING.

In continuing the study—see *The Chemical News*, 1923, CXXVII., pp. 225, 257, 272, 290—attention should again be drawn to the planetary bodies, in particular the minor planets, or asteroids as they are commonly called (see Part III.); as there is some likelihood of the distribution of these small bodies in space following a place law similar to the distribution of lines in the hydrogen spectrum. With this view in mind the writer has examined the distribution of the minor planets as given in the *Encyclopædia Britannica*, 1911, 11th Edition, Vol. XXI., p. 717.

In the accompanying diagram. I. shows the distribution as given in the Encyclopædia, while II. (explained below) is taken from Sommerfeld's "Atomic Structure and Spectral Lines," p. 210. The letters and brackets are added by the present writer for purposes of comparison. It will be seen how closely the maxima and minima coincide in these two curves, like letters indicating similar characteristics, and the brackets indicate minimum values and gaps. In the diagram (II.) representing the hydrogen spectrum, the place where the α line would fall is on the left side, and similarly the planets occur in greater orbits as one proceeds from right to left, the base line, if continued, passing through the sun. In both cases the highest points occur at A.

In explanation of the curve (II.) for hydrogen, the following from Sommerfeld's book, pp. 209, 210, will make the matter clearer: "Besides the Balmer spectrum to be understood in the general sense of equation (5), hydrogen possesses another spectrum of quite a different nature, the so-called '*many-lines spectrum*' (*Viellinienspektrum*). In contradiction to Balmer's 'four-line' spectrum (called so, occasionally in view of its four lines $H\alpha$, $H\beta$, $H\gamma$, $H\delta$ in the visible [though some writers include the $H\epsilon$ line which is in the ultra-violet]), the many-lines spectrum is to be regarded as a *band spectrum*, although it does not exhibit the external signs of band-spectra, namely, the accumulation of the lines at certain heads of the bands and the repetition of these bands, constituting flutings. From the great number of lines observed, however, individual groups of lines may be separated out, which follow the laws of band lines (set up by Deslandres—see Fulcher, *Physikal. Zeitschr.*, 1912, p. 1140; Crose, *Ann. d. Phys.*, I., p. 37), and which also show themselves to be related in that they behave similarly in the Zeeman effect. The many-lines spectrum arises in the Geissler tube at lower discharging potentials than the Balmer spectrum. The question as to the carrier of the many-lines spectrum is a subject of great controversy. The later experimental investigations, in particular a work of E. Gehrcke (Cf. *Report of the Physikal-Techn. Reichsanstalt*, 1921) leave no



room for doubt that its carrier is the hydrogen molecule and not the hydrogen atom. From the point of view of theory, only the H_2 molecule can come into question at all as the carrier of the many-lines spectrum, on account of the great complexity of the latter. Actually, we shall see in Chapter VII. that the modern theory of band-spectra, even if it cannot predict quantitatively the frequencies of the many-lines spectrum, it can at least completely account for its general character qualitatively if its calculations are based on the mass and size of the H_2 molecule. To give the reader at this early stage a general survey of the distribution and density of the lines, we give here as a résumé of the empirical data the accompanying curve [II.] that has been calculated and drawn by K. Glitscher (*Sitzungsber. d. bayer. Akad.*, 1916, p. 125). At regular intervals of 100 wave-numbers it gives as ordinates the total intensity of the lines that have been measured in each of these intervals, and the intensity of which has been estimated. The end-points of the ordinates have been connected by a smooth curve. This curve is the schematic picture of the distribution of intensity in the many-lines spectrum, and would be obtained directly if, for example, the action of the Balmer lines were eliminated and the whole spectral region were photographed with a greater width of slit and measured photometrically."

Commenting on the above, it will be seen that the development of this study is in general harmony with the foregoing deductions; and the inference is that the law of distribution, whether it involves electrons, atoms, molecules, minor planets, or planets, is of common origin; and, as was already stated in Part II., the law of the part is the law of the whole. Strictly speaking, perhaps one should say that the law of the part is translatable into the law of the whole, or vice versa.

This idea may seem strange to many who have not followed the trend of modern research in directions that point in some ways to this conclusion.

Now to show here this "trend," the following, taken from the *Encyclopædia Britannica*, supplement, 1922, vol. XXXII., p. 31, will suffice: "*Spectra and the Periodic Table.*—Attention is being drawn more and more to the relation of the spectrum to the periodic table of the elements. While it cannot be said that the relation is known with any approach to completeness, a number of important facts have been noted which may ultimately prove of great service in the interpretation of the table. It has long been known that, when doublets or triplets occur in the spectra, the wave-number separations of their components (which are constant in the sharp and diffuse series) are approximately proportional to the squares of the atomic weights of the elements producing the spectra—so long as those elements belong to the same family group. The Zeeman effect also is generally the same for lines of corresponding series in the spectra of elements belonging to the same group. But perhaps the most comprehensive connection of spectra with the periodic table is established by the 'displacement law' of Kossel and Sommerfeld (*Verh. Deut. Phys. Gesell.*, 1919). It has been observed that the 'complexity' of the lines of a series—*i.e.*, their character as singlets, doublets, or triplets—is constant throughout a group, but varies from one group to another. The displacement law states that, when an element is ionised, the enhanced series takes on the same type of complexity as the arc series produced by the element to the left (*i.e.*, in the preceding group) in the periodic table. It is assumed that electrons arrange themselves round the nucleus in rings, and that spectrum phenomena are produced by electrons in the outer ring. If the outer ring contains an odd number of electrons, the spectrum will show triplets and singlets. In the periodic table each element contains one outer electron more than its neighbour in the preceding group, while a group consists of elements having the same number of electrons in the outer ring. It follows that the removal of an electron from an element [atom] will make the outer ring similar to that of the immediate forerunner of the element in the table, and so make the enhanced lines of the first element of the same type of complexity as the arc lines of the second. Removal of a second electron would restore the arc type of complexity, for the number of outer electrons would again become odd or even, as the case might be. A second ionisation is difficult to bring about in most cases, but with silicon it is probable that one, two, and even three electrons have been removed, step by step, thus making possible four distinct spectra. These appear to show the alteration of complexity required by the displacement law. The table here gives the types of series produced by the neutral and ionised elements of the various groups, so far as they are known at present."

Group	VIII. or O.	I.	II.	III.	IV.	V.	VI.	VII.
Arc	N.C.A.	D.	T. & S.	D.	T?	D?	T.	(?)
Enhanced	(?)	N.C.A.	D.	T. & S.	D?	T?	D?	T?

N.C.A. = not completely analysed. S = singlets. D = doublets. T = triplets.

"The spectra of the higher groups are much more complex than those of the lower ones. Their series, if they possess any, are possibly of a different type from those with which we are familiar. The displacement law, however, suggests that, by repeated ionisations, series—and therefore terms—might be detected in each spectra, of the same kind as those of the groups of elements on the left. But since, with each successive ionisation, the term constant, N, is multiplied in the ratio 1 : 4 : 9 : 16, etc., the chief series lines might tend rapidly to approach the far ultra-violet and become difficult to observe."

SUMMARY OF PARTS III. AND IV.

It was shown that the radial distribution of the planets, taken in mean distances from the sun in millions of miles divided by 10, corresponded for a consecutive series of planets with the α, β, γ, δ, ϵ group numbers of the periodic table, which can be derived from the five correspondingly lettered lines of the Balmer spectrum of hydrogen.

It is here shown that the distribution of the minor planets in groups follow somewhat closely the line-intensity curve of the many-lines spectrum attributed to H_2 as the carrier; and these studies seem to show that the law of the part can be transformed into the law of the whole or *vice versa*, so that the law of distribution, whether it involves electrons, atoms, molecules, minor planets, or planets, is of common origin; and underlying all this phenomena there seems to be something that may be referred to as a "place principle." It is of course known that all the minor planets have not been discovered, their number being of the order of 1,000, but a sufficient number are known to show a characteristic type of distribution as indicated by the diagram.

INDIGOID DYESTUFFS.

PART I.

By R. F. HUNTER, F.C.S.

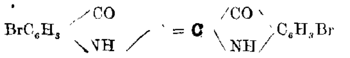
Some months ago (see *The Chemical News*, July 13, this Vol. pp. 17-18), an article was published on "Sulphur Dyes." It is now proposed to deal in something of the same way with some of the other important classes of synthetic colouring matters, and the first group to be dealt with is the indigoid dye family. It is not intended to deal exhaustively with the subject, but only a few standard compounds will be dealt with. The practical side of the preparations will not be considered, since it has been very fully dealt with in the last two chapters of Thorpe and Ingold's "Vat Colours."

Before proceeding to the subject proper, it might be of interest to give the historical side of indigoid dyestuffs some consideration.

The famous Tyrian purple, or rather "the purple of the ancients," is the only vat dye which we have records of for some fifteen hundred years before the Christian era. The colour was obtained from an excretion from certain shell fish found along the coasts of Tyre. This dye was the most prized of colours, and regarded as an emblem of royalty, and fit for the highest services of religion. By combining the infusions of different kinds of shell fish, the Phœnicians were able to vary the colour, some shades tending toward red and some toward blue, the two shades most mentioned in the English versions of the Old Testament being described as "blue" and "purple." Accounts of the manufacture of this substance are given by various Latin writers, among whom we might mention Cassidorus, Pollux, Vergil, Lucretius, and Pliny. Probably the colour was introduced into Europe about 500 B.C. The Greeks paid considerable attention to colours, the Romans obviously obtaining their knowledge of colouring matters from the Greeks. During the Middle Ages, the knowledge of purple was lost, save in the writings on the ancients. Canniparius, writing in Italy at

the beginning of the 17th century, speaks of the purple as being known only through ancient writings.

Cole made observations on the subject in the *Phil. Trans.* 1685, Réaumur in 1710 (in *Mem. de l'Acad, Royale des Sciences*, 1711) made an observation on a number of purple-giving molluscs on the coast of Poitou. Duhamel, in 1736, recorded similar observations in the same scientific paper. Bancroft made some investigations on the subject in 1813. Schunk (1879) investigated the substance. Friedlander took up the subject in 1907. He isolated the colouring matter, preparing 1.4 gm. of pure substance from the glands of 12,000 specimens of the *Murex brandaris*. The substance was insoluble in alcohol, ether, ligroin, chloroform, acetic acid and acetone; soluble with difficulty in hot pyridine, in which it dissolved to give red violet solutions. Analysis indicated the formula $C_{16}H_8Br_2N_2O_2$. This represents 2:8-dibromoinderubins and 1:6-dibromo indigos. The substance was found to be identical with 6:6′ dibromo-indigo previously synthesised by Sach's and Kemp from p bromo o nitro benzaldehyde:



6:6′ Dibromoindigo.

We now come to the question of natural indigo. From the earliest times the indigo plant was cultivated and the indigo extracted from it by the Hindus. Its preparation is described in old Sanskrit scripts, and these scripts show that its mode of preparation scarcely underwent any alteration during the centuries preceding the discovery of India by the Dutch.

From India the knowledge of indigo spread along the trade routes through Persia to Syria and Arabia and thence to Egypt. The Egyptians used indigo extensively. This is revealed by analysis of mummy cloths. The knowledge of indigo reached China about 700 A.D. From Egypt the knowledge passed to Greece, and thence to Rome. During the dark ages between 500 to 1200 A.D., the knowledge was almost lost in Europe save in a few Italian m·ies. From Italy the knowledge spread to perio·e and Flanders during the thirteenth cannot . The Flemish and Italian dyers with any aro in the fourteenth century unber of im·ot·xcited the enmity of the older tinued well into the sixteenth century, and the Black Dyers were so successful that indigo was prohibited as being a newly invented, deceitful, eating and corrosive dye. The Dutch, after 1602, however, began to import large quantities of indigo, and the superiority of this caused it to take the place of the woad industry to an enormous extent. In France the use of indigo was allowed when mixed with a hundred times its weight of woad in the "woad vat."

The principal plants cultivated for the purpose of obtaining indigo belong to the genus *Indigofera*, and have been grown in India, China, Japan, Java and the Phillipine Islands, Central America and the West Indies, Brazil and Madagascar.

The principal species are:—

Sumatrana,
Acreta,
Paucifolia,
Tinchloride,
Secundiflora,
Disperma, and
Argentea.

The colour-forming principle in the *indigofera* is a glucoside of indoxyl, indican, which, by the action of enzymes present in the plant, is hydrolysed, yielding free indoxyl. This, by atmospheric oxidation, proceeds to indigo. The manufacture of indigo (natural) hence consists of the two essential operations: firstly, the steeping of the plant in water when fermentation takes place and hydrolysis of the glucoside follows; secondly, the precipitation of the colouring matters from the solution of indoxyl by the action of air. The chemicals used in the manufacture of natural indigo have three purposes: first, to purify the water for steeping; secondly, as an adjunct for steeping; and lastly, in the oxidising process.

Natural indigo contains, as well as indigo and indirubin, traces of uncondensed isatin, a yellow colour which has been isolated and identified as the tetrahydroxy flavone; kæmpborol and a number of brown amorphous bodies which dissolve in alkaline reducing solutions but cannot be used to colour cotton fibre. There is also present a horn-like substance known as indigo gluten, and certain mineral matter. The most important constituent of the natural substance from the point of view as a dye is indigo or indigotin, the dyeing properties of which are due to its capability of passing into a leuco compound, "indigo white," in

solution when treated with alkaline reducing agents. In alkaline solution this penetrates the fibres of cotton, and is reoxidised to indigo by atmospheric oxidation dyeing the fibre. Indirubin undergoes similar conversion with alkaline reducing agents.

We now come to consider one of the most important questions of to-day, *viz.*. synthetic indigo. In 1841, Erdmann and Laurent oxidised indigo to isatin. Laurent, by chlorination and bromination of this, isolated mono and dichloroisatin and dibromoisatin. Bayer commenced his researches on isatin in 1865 in conjunction with Knop, attempting to reduce the substance to indigo. The attempt failed, but resulted in the isolation of dioxindole and oxindole. He regarded oxindole as a phenol of a substance, $C_6H_4 : C_2H_3N$, to which he gave the name indole, and reduced oxindole to indole in 1866 by passing the vapour of oxindole over heated zinc dust.

In 1878 Bayer synthesised isatin by the scheme suggested originally by Kekulé. Starting with phenylacetic acid, he converted this into successively nitrophenylacetic acid, aminophenyl acetic acid, oxindole, nitro oso oxindole, amino oxindole, and finally this, with ferric chloride, into isatin.

Indigo had been obtained in traces by Emmerling by distilling o nitro aceto phenone with zinc dust and soda lime. This reaction was shown by Bamberger to depend on the intermediate reduction product methylanthranol. The first rational synthesis of indigo was accomplished when Bayer synthesised isatin, for Bayer and Emmerling had shown in 1870 that isatin can be reduced to indigo by treatment with PCl_3, followed by contact with atmosphere. This, however, was improved a year after the isatin synthesis by Bayer, who prepared isatin chloride by the action of phosphorus pentachloride on isatin, and reduced this by means of hydriodic acid to indigo in acetic acid solution.

A year later, Bayer obtained indigo from o nitro cinnamic acid by the following scheme: By the action of KOH on the dibromide he obtained o nitro phenyl propiolic acid. This, on heating with alkalis, is converted into isatin, and by heating with alkalis in the presence of glucose is converted into indigo. Also, the ethyl ester of o nitro phenyl propiolic acid, on treatment with CO H SO_4, proceeds to the isomeric ester of isatogenic acid. This, on hydrolysis, passes into the acid and then into isatin, and on reduction yields the ethyl ester of indoxylic acid. The free acid, on heating, loses CO_2 and passes into indoxyl, and this, on oxidation, passes into indigo.

(*To be continued.*)

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, NOVEMBER 22.

SPECIAL GENERAL MEETING TO CONSIDER THE ANNUAL REPORT OF COUNCIL.

Papers read:—

F. SIMEON, *The Carbon Arc Spectrum in the Extreme Ultra-violet.—II.* Communicated by Prof. A. W. Porter, F.R.S.

The results may be summarised as follows:—

(1) The spectrum of the carbon arc in vacuum extends as far in the extreme ultra-violet as that of the spark, with the exception of a very faint line at 360.5 A, and about 25 lines have been added to the arc spectrum as already recorded.

(2) The L series of carbon can be excited by a potential of between 30 and 40 volts.

(3) Reasons are given for thinking that a number of lines in the carbon spectrum are true "arc" lines.

(4) Providing the grating will give radiation in the short-wave region, the same technique suffices to photograph the spectrum from 1850 A to 370 A.

H. J. GOUGH and D. HANSON, D.Sc., *The Behaviour of Metals subjected to Repeated Stresses.* Communicated by Sir Joseph Petavel, F.R.S.

The subject of the paper is the effect of static and alternating stresses on the micro-structure of metals, the main object of the research being to determine whether the crystalline structure of a metal can be affected when subjected to ranges of stress *less* than the limiting range of stress (fatigue range). It is shown that with "Armco" iron, mild steel, and copper, crystalline "slip" occurs at ranges of stress considerably less than the fatigue range.

In explanation of this result, it is suggested that metals can be "strain-hardened" under the action of alternating stresses, as

well as under static stresses; it is further suggested that fracture occurs, in a metal subjected to alternating stresses, when a certain limiting strain for the material is exceeded.

The paper is divided into the following sections:—

(1) Preliminary Mechanical Tests.
(2) Study of the Microstructure under Static Stresses.
(3) Study of the Microstructure under Alternating Stresses.
(4) Discussion of the Results with respect to other known Phenomena of the Fatigue of Metals.

W. Sucksmith and L. F. Bates, *On a Null Method of Measuring the Gyro-Magnetic Ratio.* Communicated by Prof. A. P. Chattock, F.R.S.

A new method is described of determining the gyro-magnetic ratio, and results obtained with it are given. As in the ordinary resonance method, the specimen, suspended vertically by a fine wire along the axis of a helix, is magnetised by an alternating current of same frequency as natural frequency of the system; but the resulting resonance amplitude is reduced to zero by a series of impulses timed to oppose those due to gyro-magnetic effect.

As no measurement of magnetic moment, frequency, or damping is involved, a considerable gain in precision is obtained. The method is independent of time-lag in magnetisation, and so can be applied to Heusler alloys.

The following table contains mean values of ratio obtained for iron, nickel and Heusler alloys:—

Metal.	K.
Iron	0.503
Nickel	0.501
Heusler alloys	0.501

The number is in every case 0.5 within the limits of experimental error, and corroboration is thus afforded of measurements of the ratio recently carried out in this University by an independent method by Messrs. Chattock and Bates.

J. H. Shaxby, *Studies in Brownian Movement.—II. The Determination of Avogadro's Number from Observations on Bacteria (Cocci).* Communicated by Prof. S. W. J. Smith, F.R.S.

A determination of Avogadro's number by the method of measuring the displacements, due to their Brownian movements, of small spheres suspended in water, was carried out with cocci. Their surfaces may fairly be supposed to be "wetted" so that there is no slip between the water immediately adjacent and the spheres themselves, and the resistance which might arise from electrical sources depending on slip is avoided. Precautions were taken that no mobements other than Brownian should be recorded. The value of N thus found, from the large number of observations made on *Staphylococcus albus*, is 6.08×10^{23}.

Papers read in title only:—

H. Hartridge, Sc.D., and F. J. W. Roughton, *The Kinetics of Hæmoglobin.—II.* Communicated by Prof. J. N. Langley, F.R.S.

A. F. A. Young, *The Thermionic and Photo-Electric Properties of the Electro-Positive Metals.* Communicated by Prof. O. W. Richardson, F.R.S.

O. F. T. Roberts, *The Theoretical Scattering of Smoke in a Turbulent Atmosphere.* Communicated by Dr. G. C. Simpson, F.R.S.

THE ROYAL SOCIETY OF ARTS.

On Monday, November 19, the Cantor Lecture (II.), entitled *The Cultivation of Cocoa in British Tropical Colonies*, was given by Samuel Henry Davies, M.Sc., F.I.C.

On Wednesday, November 21, at the Ordinary Meeting, a paper entitled *Forgeries of Ancient Stained Glass* was read by J. A. Knowles. The Right Hon. the Earl of Crawford and Balcarres, K.T., P.C., F.S.A., presided.

On Tuesday, November 27, at the meeting of the Dominions and Colonies Section, a paper entitled *The West Indies* was read by the Viscount Burnham, C.H., LL.D., D.Litt., M.A. The Lord Askwith, K.C.B., K.C., D.C.L., Chairman of the Council, presided.

On Wednesday, November 28, at the Ordinary Meeting, a paper entitled *The Effect of Sun, Sea and Open Air in the Treatment of Disease* was delivered by Sir Henry John Gauvain, M.A., M.D., M.Ch., Medica

Superintendent of the Lord Mayor Treloar Cripples' Hospital. Lord Dawson of Penn, G.C.V.O., K.C.M.G., C.B., M.D., F.R.C.P., M.R.C.S., presided.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

The next meeting of the Society will be held on Wednesday, December 5, at the Chemical Society's Rooms, at 8 p.m.

The following papers will be read:—

Crystalline Bromides of Linseed Oil, by HAROLD TOMS, M.Sc. (under the Analytical Investigation Scheme).

The Plea for Standardisation, by M. S. SALAMON, B.Sc.

Note on the Estimation of Chromium, by HUBERT T. S. BRITTON, M.Sc., F.I.C.

The Colorimetric Estimation of Lead in Cream of Tartar, by R. L. ANDREW.

PHYSICAL SOCIETY OF LONDON.

A meeting of the Society was held on Thursday, November 29.

A joint discussion with the Institution of Electrical Engineers took place on the subject of "Loud Speakers for Wireless and other Purposes."

FIRST SESSION OF DISCUSSION.

General Principles involved by the Accurate Reproduction of Sound by Means of a Loud Speaker, by PROF. A. O. RANKINE.

Theory of Loud Speaker Design. (Some factors affecting faithful and efficient reproduction. Causes of inefficiency. Economy in amplifiers resultant on improved efficiency. With demonstration). By DR. L. C. POCOCK.

The Electrical Side of the Phenomena of Low-frequency Amplification in Wireless Circuits. Causes of distortion and means of elimination. Demonstration. By PROF. C. L. FORTESCUE.

The Problem of Distortion in the Reproduction of Sound by the Gramophone, by MR. H. L. PORTER.

General Discussion.

SECOND SESSION OF DISCUSSION.

Distortion in Audio-Circuits. Relative importance of various frequencies. Demonstration of effect of elimination of various frequency bands. Demonstration of nodes and anti-nodes in an auditorium. *Methods*, direct and indirect, of *Measurement of the Efficiency and Faithfulness of Loud-Speaking Telephones.* By MR. E. K. SANDEMAN, B.Sc.

The Overtones of the Diaphragm of a Telephone Receiver. Their effect in causing distortion. With Demonstration. By PROF. J. T. MCGREGOR-MORRIS and PROF. E. MALLETT.

Architectural Acoustics. Its relation to Loud Speaker operation. By MR. G. A. SUTHERLAND, M.A.

Some Directions of Improvement of the Loud-Speaking Telephone. Action of the Frenophone. With Demonstration. By MR. S. G. BROWN, F.R.S.

The Characteristics of the Gaumont-Lumière Loud Speaker. With Demonstration. By CAPT. P. P. ECKERSLEY.

General Discussion (continuation of).

Visits were arranged, by kind permission of the British Broadcasting Company, to their Studio on Savoy Hill.

Proceedings at the meeting on November 9, Alexander Russell, M.A., D.Sc., in the chair:—

A Demonstration of *Experiments on the Reproduction of Vowel Sounds* was given by SIR RICHARD PAGET.

The author found that each of the vowel sounds comprises two components lying within two ranges two or three semitones in extent, the two ranges being characteristic of the vowel and separated by an interval of from three tones to three octaves, according to the nature of the vowel. The devices shown for reproducing vowels consisted in their simplest form of pairs of resonators tuned to the tones characteristic of various vowels and so arranged that the sound from

an artificial larynx or squeaker could be passed through them in series or in parallel. Certain vowels in which the upper resonance is a harmonic of the lower can a so be produced by means of a single resonator. *Consonants are found to depend in part on* characteristic resonances and their rate of change, and in part on the release of air pressure in the compound resonators, some of which were caused to emit words by opening and closing their orifices suitably by *hand.* The author, in *illustration, arranged* his hands to form a double resonator in imitation of the human mouth, and passed through them the sound from a squeaker representing the larynx. By manipulating the fingers and hands, he was able to pronounce *easily recognisable sentences.*

A discussion followed.

A paper on *Scattering of Light by Carbon Dioxide, Nitrous Oxide, and some Organic Vapours*, by A. L. NARAYAN, M.A., A.INST.-P., was read by Lord Rayleigh in the absence of the author.

It has been shown by Lord Rayleigh that the light scattered laterally by the molecules of gases is not completely polarised, but contains a component polarised at right angles to the direction which is predicted by *theory for a spherical molecule, the two* components being conveniently referred to as the "wrong" and the "right" components respectively. The author was able to employ sunlight for illuminating gases and vapours, which he enclosed in a jointless tube. The strengths of the components were compared both by direct photometry and by photometric comparison of their effects on a photographic plate, improved thermo-electric apparatus being employed for the latter purpose. Lord Rayleigh's results were confirmed, particularly in the case of CO_2 and N_2O. It is suggested that the difference in the scattering power of these two gases is contrary to the prediction of the Lewis-Langmuir theory of the atom.

DISCUSSION.

Prof. A. O. Rankine said that his experiments, referred to, merely showed that the collision-area of the molecules in question varies with orientation in a manner consistent with the Lewis-Langmuir theory; it may be possible to invent other molecular models with which the experimental results be equally consistent. These results, ...er. are relevant only to the external form of the molecules, for viscosity may be presumed to be unaffected by the distribution of mass between the nuclei. Thus the masses of the nuclei would, according to *theory, be 8, 6, and 8, in* CO_2, *and* 7, 8, and 7, in N_2O; and since, as Sir J. J. Thomson has suggested, these molecules would have different moments of inertia though their masses would be equal, it might be expected that they would differ in their polarising effect.

Mr. J. Guild said that in the measurement of such small intensities of light a *large experimental error must be expected, so that the agreement* between the author's and Lord Rayleigh's results was much better than might have been expected. Particularly in the case of vapours, where the percentage of the "wrong" component is small, the Nicol system is being used under *the most disadvantageous conditions,* which are calculated to evoke various defects even in the most perfect apparatus. As regards the photographic method of photometry, would not the actinic effects of the "right" and of the "wrong" components *be different? In the case of* the Tyndall effect due to larger aggregates, the intensities of the corresponding components are respectively proportional to the inverse fourth and the inverse eighth powers of the wave length, so that the "wrong" component *would be much bluer than the "right"* and have a disproportionate effect on the plate. The author mentions that many iridescent colours in Nature are due to scattering of light. It is interesting to note that many other common colours have been traced to the same cause, *e.g.*, the blues of *the sky, of birds' feathers, and of the eyes* of blondes.

Lord Rayleigh, in reply, said that he did not suppose the authors of the Lewis-Langmuir theory regarded their model as a real representation of the atom, consistent with all the latter's properties. It is rather a schematic diagram adapted to summarise *certain groups of properties,* and might well be inconsistent with others. The chromatic difference between the components in the Tyndall effect, though not completely accounted for, is a fact; but the effect is not comparable with that under discussion, the *smallest particles which show the Tyndall* effect being large compared with molecules. That there is no substantial chromatic effect on the photographic plates is proved by the agreement of the results of the

photographic method with those of direct photometry.

On the Measurement of the Surface Tension of a Small Quantity of Liquid, by ALLAN FERGUSON, M.A., D.Sc.

If a small quantity of liquid—one cubic millimetre or less—be placed in a vertical capillary tube, its surface tension may be determined by applying pressure to the upper end of the tube, and measuring the pressure necessary to force the liquid into such a position that the meniscus at the lower end of the tube is *plane*.

Interfacial tensions may also be determined in this way.

If no restriction be placed on the amount of liquid available, a simple apparatus may be used, by means of which the ordinary surface tension of a liquid, or the interfacial tension between two liquids, may be measured in several different ways.

THE GEOLOGICAL SOCIETY OF LONDON.

At the meeting on November 7, Prof. A. C. Seward, Sc.D., F.R.S., President, in the chair, the following communications were read:—

On the Skeleton of IGUANODON ATHERFIELDENSIS *sp. nov., from the Wealden Shales of Atherfield (Isle of Wight)*, by the late REGINALD WALTER HOOLEY, F.G.S. Read by Dr. A. Smith Woodward, F.R.S., F.G.S.

The Igneous Rocks of the Tortworth Inlier, by PROF. SIDNEY HUGH REYNOLDS, M.A., Sc.D., F.G.S.

At the meeting held on Wednesday, Nov. 21, the following communication was read:

The Development of the Severn Valley in the Neighbourhood of Iron-Bridge and Bridgnorth, by L. J. WILLS, M.A., PH.D., F.G.S. With a Section on the Upper Worfe Valley, in collaboration with E. E. L. Dixon, B.Sc., F.G.S.

THE INSTITUTION OF MINING ENGINEERS.

The thirty-fourth annual general meeting of the Institution of Mining Engineers was held on Thursday, November 29.

The following papers were read, or taken as read, and submitted for discussion:—

Hydraulic Stowage at the Dalzell and Broomside Collieries, by PROF. R. W. DRON, M.INST.C.E.

Some Effects of High Air-Temperatures upon the Miner, by PROF. K. NEVILLE MOSS, M.Sc. (Sixth Report to the Committee on "The Control of Atmospheric Conditions in Hot and Deep Mines.")

Strata Temperatures in South Wales, including Pembrokeshire, by T. D. JONES, M.Sc. (Seventh Report to the Committee on "The Control of Atmospheric Conditions in Hot and Deep Mines.")

The Specific Heat of Coal, by G. COLES, B.Sc. (Eighth Report to the Committee on "The Control of Atmospheric Conditions in Hot and Deep Mines.")

The following paper will be submitted for further discussion:—

The position of Mechanical Engineering in Colliery Operations, by SIR WILLIAM ELLIS, G.B.E., D.ENG. (see *Trans. Inst. M.E.*, 1923-1924, vol. LXVI., page 85).

THE OPTICAL SOCIETY.

THE 1923 THOMAS YOUNG ORATION.

A meeting of the Society was held at the Imperial College of Science and Technology, on Tuesday, November 27, when the Thomas Young Oration was delivered by DR. M. VON ROHR, Jena, the subject being *Contributions to the History of the Spectacle Trade from the earliest times to Thomas Young's Appearance.*

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Periodic Trigger Reception, by E. V. APPLETON, M.A., D.Sc., and F. S. THOMPSON, B.A., Royal Corps of Signals.

The phenomenon of oscillation hysteresis exhibited by simple triode generators was discussed theoretically. A practical method of reception in which this phenomenon is utilised in a periodic manner was described. This method, which for convenience may be termed "periodic trigger reception," is

iitable for continuous-wave and spark signals.

A *low-frequency electromotive force is in*oduced in the grid circuit of a simple trile oscillator in such a way that high-equency oscillations are not produced in e absence of an incoming signal. A small gnal of high frequency is, however, suffient to produce a train of free oscillations ice every low-frequency cycle. Such free scillations are rectified by the triode, and signal of the impressed low frequency is eard in the receiver telephones.

The system differs fundamentally from ie Armstrong super-regenerative receiver the following respects:—

(*a*) The ordinary oscillation-hysteresis iaracteristic is followed "adiabatically";

(*b*) No self-oscillations are produced in ie *system in the absence of an incoming* gnal; and

(*c*) The amplitude of the telephone signal practically independent of the amplitude f the incoming signal and not proportional › it as in super-regenerative receivers.

It has been discovered experimentally iat *oscillations may be maintained in a* mple triode generator with extreme negave grid potentials such as would cut off ie anode current entirely under normal onditions. A simple theory for the condiions necessary for such maintenance is iven. *An oscillator of this type is very fficient in that anode and grid currents are* nly permitted to flow for a very small part f the cycle.

A Dynamic Model of a Valve and Oscillatıg Circuit, by R. C. CLINKER, Member.

A mechanical model was described which epresented the action of a 3-electrode valve vhen coupled to an oscillatory circuit. A string moving around pulleys, one of which s *driven by a small motor, represents by its* notion the current through the valve. The oscillatory circuit is represented by a spring and a weighted pulley. By a mechanical coupling between the spring and a brake on the driving motor, the effect of the intermittent current through the valve is *obtained, and the system* exhibits self-maintained oscillations.

THE SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

ORDINARY MEETING.

... at the Chemical Society's Rooms on Wednesday, November 7, Mr. P. A. Ellis Richards, President, in the chair.

Certificates were read for the first time in favour of: Mr. Robert Charles Frederick and Hubert Thomas Stanley Britton, M.Sc. (*Lond.*), F.I.C.

Certificates were read for the second time in favour of: Messrs. Laurence Eversley Campbell, M.Sc. (Lond.), F.I.C.; John Troubridge Hannen, B.A. (Cantab.), A.R.C.Sc., A.I.C.; Cyril Langley Hinton, F.I.C.; Douglas William Kent-Jones, B.Sc. (Lond.), F.I.C.; Thomas William Alan Shaw, M.Sc. (Liv.); William Hall Simmons, A.I.C.; Kenneth Edward Nethercoate Williams; Percy Noel Williams, M.Sc. (Liv.), A.I.C.

The following papers were read:—

The Gold-Beaters' Skin Test for Tannins, by PHYLLIS H. PRICE, B.Sc.

Tanning consists in the fixation of the tannins by animal fibre. A reliable tannin test must therefore demonstrate this specific property, and such a test was described from Dr. Nierenstein's laboratory by Miss E. Atkinson and Miss E. O. Hazleton (*Bio. Chem. Journ.*, 1922, XVI., 516). Their method consisted in the fixing of the tannin on gold-beater's skin and the subsequent staining of the skin with ferric chloride. Non-tannins are not fixed on the gold-beater's skin and consequently not stained. The author has further developed the test, and finds that it is possible to detect 0.00005 grm. of gallotannin in 1 cc. of solution with the use of either ferrous sulphate, ferrous chloride or amyl nitrite fumes in place of ferric chloride. It was also noticed that on decolorisation with dilute hydrochloric acid, skins previously treated with pyrogallol tannins are completely decolorised, whereas those treated with catechol tannins have a reddish stain left on them. This is suggested as a test for Phlobaphenes.

Determination of Nitrogen in Coal, by W. DONOVAN, M.Sc.

The author confirms the work of Fieldner and Taylor, Terrea, Fleischer, and others, who observed that the Dumas process, as described in the report of Research Committee of the Institute of Gas Engineers, and the Kjeldahl method both gave results below the correct one, the former owing to incomplete combustion, the latter by loss of gaseous nitrogen, but points out that the

Dumas process makes no provision for the complete removal of hydrocarbons. Concordant results are, however, obtained with the Dumas process (hydrocarbons having been completely removed) by the addition of a constant 0.2 per cent. to the Kjeldahl gure, using mercury as a catalyst.

The Estimation of Lead in Potable Waters and in Urine, by JOHN C. THRESH, M.D., D.Sc., F.I.C.

In estimating traces of lead in coloured moorland waters the influence of the colour is not always removed by making the standards with the same water diluted with distilled water. The presence of even one part of copper in 100 millions reduces the depth of the tint given by lead, and iron in solution also interferes with the colorimetric estimation of lead, and accounts for most of the discrepancies obtained with moorland waters. It is essential that the standard should have the same acidity and contain the same acid as the water or urine under examination. A sensitive method of testing for lead in urine is described, and it is shown that three kinds of filter paper contained sufficient lead to cause urine which was free from lead to give a positive result in the test.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

A paper, entitled, *The Electrification of the French Midi Railway*, was read by MON. A. BACHELLERY, Ingénieur-en-Chef, Chemins de Fer du Midi, France, and discussed at a joint meeting of the Institution of Electrical Engineers and the Société des Ingénieurs Civils de France (British Section), held on Thursday, November 22.

After a brief description of the experiments made before the war on the Midi Railway in the way of electric traction, the author gives an account of the extensive electrification work now pursued by that company in accordance with the new standard regulations of the French Government, and of the first results already obtained on the electrified lines.

LECTURES IN CHEMISTRY.

A course of three lectures on *Some Chapters in the Recent Development of the Theory of Electrolytic Dissociation* will be given at University College, London (Gower Street, W.C.1), by PROF. J. N. BRONSTED (Professor of Chemistry in the University of Copenhagen), at 5.30 p.m. on Monday, Dec. 10, Wednesday, Dec. 12, and Friday, Dec. 14.

At the first lecture the chair will be taken by Professor F. G. Donnan, C.B.E., F.R.S.

The lectures are addressed to advanced students of the University and to others interested in the subject. Admission is free, without ticket.

WHAT CHEMISTRY SHALL BE TAUGHT IN HIGH SCHOOL AND HOW IT SHALL BE CORRELATED WITH COLLEGE CHEMISTRY.

BY LOUIS W. MATTERN.

Chemical Department McKinley Technical High School, Washington, D.C.

(*Abridged from the "School Science and Mathematics*," Vol. XXIII., No. 7, October, 1923.)

No endeavours are so prolific of far-reaching benefits to the betterment of mankind as those which contribute to the aim of education, as expressed by William C. Ruediger, "To educate a person, means to adjust him to those elements of his environment that are o concern in modern life, and to develop, organise and train his powers so that he may make efficient and proper use of them." What a fine instrument chemistry may become as a contributor to develop and to carry out the two aspects of life as implied in that definition, first the objective, and second the subjective.

Objectively, first, chemical principles touch our every day physical environment at every turn in life with an illumination that reveals its indispensable usefulness in manufacturing processes, in furnishing the basic supplies of mankind through agriculture, in the rapid developments of foods and medicine, and in that proper understanding of certain phenomena and substances which is essential to their best usage in connection with personal welfare.

With regard to the subjective aspect, the qualities needed in the study of chemistry and therefore to be accordingly developed in the student, are those which operate prominently in the production of success in modern life, namely, accuracy in observation, correlation of observations and the de-

duction therefrom of principles or laws and the relation of new observations to these laws, independent judgment based on experimental evidence, the ability to check thought and imagination with experimental evidence, the indispensable virtue of thoroughness, and the very important matter of expressing clearly, either written or oral, experimental work.

Subsequent to the great developments of the possibilities of chemistry due to the urge of the researches of Black (1728-99), Cavendish (1731-1810), Priestley (1733-1804), and Lavoisier (1743-94), those interested in education not only gave chemistry a place in the colleges as early as 1767-1839, but also, later on, in the American Academy, which was developed out of a desire to do the people at large more good than the then existing Latin grammar school. At this time a new spirit in American education was struggling for bith. The American spirit in education, animated by such spirits as Benjamin Franklin, William Penn, Rensselaer, Lawrence of Harvard, Williams of Michigan, and Pugh, the first President of the Pennsylvania State College, the blacksmith apprentice, who managed to get enough elementary education to spend four years abroad, returning as an accomplished educator in agricultural science, and others—all brought science to bear upon the welfare of the people at large, both from a practical and cultural point of view. Pugh states, "The facts of science discipline the mind to habits of thought and enable one fully to comprehend the abstract principles involved in the practical operations of life." From 1819 to 1840 in North Carolina, Massachusetts, Connecticut and New York alone, thirty-five academies and secondary schools taught chemistry. It is, therefore, not surprising that the increased revelations of the wonderful possibilities of chemistry since those early days caused a large number of students in the high schools of this country to study chemistry.

This increasingly large number of chemical students is a very important field of chemical education: first, because students in high schools are especially sensitive to visions of their life's work and a long list see chemistry; second, they have the ability to successfully learn chemistry when there is not an attempt to put a quart in a pint measure—remembering that the rest of the quart can better be administered at college; third, the large number whose formal education ceases with the high school carry into citizenship that which will be helpful in creating more of an intelligent appreciation at large of the importance of chemistry and the value of its many current publications to the material well-being and benefit of mankind.

The problem of correlating the chemistry taught in high schools with college chemistry is a doubly complex problem. The college professors of chemistry receive from high schools those who have had chemistry and those who have not. The high school teachers of chemistry have in their classes those who intend to go to college and those who do not. Different high schools treat chemistry differently, both as to content and method of teaching, tsus presenting t[illegible] the colleges a variety of preparation. Since chemistry may logically play an increas-ingly important part in sigh school educa-tion, should not the American Chemica[l] Society, with its rich knowledge of chemis-try, and its wealth of educational ability help to solve the problem of how and wha[t] chemistry should be taught in the hig[h] schools?

How chemistry is taught during th[e] highly sensitive period of high school educa-tion, as well as what is taught, is excee[d]ingly important, because the habits an[d] attitude of mind then formed will hel[p] mightily to determine the extent of furthe[r] development in college chemistry. I, there-fore, suggest the following method and con-tent for high school students of chemistr[y] either for those not going to college or thos[e] who do; however, the latter is the class f[or] sheciat consideration at this time.

Stress the developyment of accuracy [in] observation, without which there can be [no] real progress in chemistry. Rober E. Ros[e] in discussing the weakness of chemists, la[ys] particular emphasis on a positive need [for] more training of the ability to obse[rve] accurately, and ascribes a lack of that al[bil]ity to "faults of our secondary schools[.]" The wide variation of materials and th[e re]actions afforded by a properly systemis[ed] series of elementary chemistry experime[nts] give an unparalleled opportunity for tra[in]ing of the power to observe.

Student laboratory experiments sho[uld] precede class-room development, there[by] getting information, not second-hand, [but] first-hand, which arouses curiosity [and] stimulates keen observation. These obs[er]vations should become the basis of cl[ass-]room development and further expansion [of] the principles taught by these experime[nts]

into their applications in every-day life. In the admirable "Report" of the Committee, appointed by the Prime Minister to inquire into the "Position of Natural Science in the Educational System of Great Britain," attention is properly called to the danger of carrying the heuristic method to an extreme; that is, to discover things through their experiments, with very little aid from their teacher. While the spirit of inquiry should saturate every experiment, it would be a waste of time to compel the students to rediscover all that they are expected to know during the limited time given to laboratory work.

(To be continued.)

GENERAL NOTES.

ANGLO-SWISS TRADE IN 1922.

The Department of Overseas Trade has received from the British Legation at Berne the following survey of Anglo-Swiss trade during 1922.

According to the recently published Customs Statistics for the entire twelve months of 1922, Great Britain maintains her position as Switzerland's chief customer. France coming next, then the United States of America, and then Germany.

According to the *Swiss Exporter* for October, the favourable marketing conditions for Swiss artificial silk are causing the "Viscose S.A." of Emmohrücke (Lucerne) to contemplate the erection of a second factory in this country. Moreover, a new undertaking for the manufacture of artificial silk is about to be established at Steckborn, by the "Borvisk" Artificial Silk Works, Ltd., of Zürich.

With regard to exports of chemicals, the increase of 10.1 million francs can be attributed almost entirely to aniline and other coal tar dyes. There is also a slight increase in these particular chemical exports, as compared with 1921 (13.1 as against 10.6 million francs), whereas there is a decrease to be noted in respect of the aggregate total of chemicals exported to the United Kingdom. This decrease applies more particularly to perfumery, cosmetics, and vegetable alkaoids. There is a notable increase in exports of technical oils and fats, which have risen from 10.7 million francs in 1921 to 58.5 million francs in 1922.

CORRESPONDENCE.

BRITISH EMPIRE EXHIBITION (1924).

To the Editors of The Chemical News.

Sirs,—It is well known to most people that at the forthcoming Exhibition next year at Wembley there will be shown a very complete representation of our present *state of knowledge of natural science.* The details of the arrangements, perhaps, are not so well known, and with a view to furnishing information to those already interested and possibly enlisting the assistance of those who have not already offered it, I shall be glad to be allowed to make the following statement:—

A Committee of the Royal Society is dealing with an exhibit illustrating, so far as space permits, researches in various branches of pure science other than Chemistry.

The Chemistry Exhibit is being organised by a Committee of representatives of all the other scientific societies dealing with science and application of chemistry. The two Committees are working in the closest possible co-operation, having three members in common in order to prevent overlapping.

The space at the disposal of the Committees is limited, but those who are able and willing to assist in the Chemistry Exhibit should communicate with Dr. Levinstein, at 166, Piccadilly, W.1, or any of the Convenors of Sections, whose names are given below, with regard to exhibits dealing with chemistry.

Subjects which are on the borderland of Physics and Chemistry, such as the Structure of the Atom, the Inner Structure of Crystals, and recent Spectroscopic work, will be dealt with by the Committee to which it is most appropriately referred. Arrangements will be made between the two Committees to exhibit the work in its most appropriate place.

Chemistry Exhibit.—Convenors:

Dr. E. F. Armstrong, F.R.S., Greenback, Latchford, Warrington; Catalysis: Fat, Hydrogenation of.

J. L. Baker, Esq., F.I.C., Dial Cottage, Cookham Road, Maidenhead; Biochemistry.

Professor E. C. Baly, C.B.E., M.Sc., F.R.S., The University, Liverpool; General Inorganic.

A. Chaston Chapman, Esq., F.R.S., 8, Duke Street, Aldgate, E.C.3; Hydrogen Ion Concentration.

C. F. Cross, Esq., B.Sc., F.R.S., 4, New

Court, Lincoln's Inn, W.C.2; Cellulose.

Professor F. G. Donnan, C.B.E., F.R.S., University College, Gower Street, W.C.1: *General Physical Chemistry.*

Professor G. G. Henderson, LL.D., F.R.S., The University, Glasgow; Terpenes.

Dr. T. A. Henry, The Wellcome Chemical Research Laboratory, 6, King Street, Snow Hill, E.C.1; Organic Chemistry Alkaloids.

Professor I. M. Heilbron, D.S.O., Chemistry Department, The University, Liverpool; Plant Colouring Matters.

Dr. J. T. Hewitt, F.R.S., Manor House, Sutton, Heston, Hounslow, Middlesex; Coal Tar Colouring Matters.

Professor J. W. Hinchley, A.R.S.M., F.I.C., The Institution of Chemical Engineers, N.307, Abbey House, Victoria St., Westminster, S.W.1; Chemical Engineering.

Principal J. W. Irvine, C.B.E., F.R.S., *The University House, St. Andrews, Fife;* Sugars.

Dr. Arthur Lapworth, D.Sc., F.R.S., The University, Manchester; Valency Theories and Theories of Chemical Combination.

Professor J. W. McBain, M.A., F.R.S., The University, Bristol; Colloids.

Sir Henry Miers, LL.D., F.R.S., Birch Heys, Cromwell Range, Fallowfield, Manchester; Crystallography and Crystal Structure.

Dr. W. R. Ormandy, F.I.C., 18, Belsize Grove, Belsize Park, N.W.3; Plastics.

Professor F. L. Pyman, D.Sc., F.R.S., College of Technology, Manchester; Alkaloids.

R. B. Pilcher, Esq., O.B.E., The Institute of Chemistry, 30, Russell Square, W.C.1; Historical.

Sir John Russell, D.Sc., F.R.S., Lawes Agricultural Trust, Rothamstead Experimental Station, Harpenden; Agricultural Chemistry.

Dr. T. Slater Price, O.B.E., F.I.C., British Photographic Research Association, 30, Russell Square, W.C.1; Photography.

Professor A. Smithells, C.M.G., B.Sc., F.R.S., 68, Lissenden Mansions, Highgate Road, N.W.8; Flame, Fuel and Explosion Waves.

Commander R. E. Stokes-Rees, R.N., The Institution of Petroleum Technologists, 5, John Street, Adelphi, W.C.1; Apparatus.

Professor J. F. Thorpe, C.B.E., F.R.S., The Imperial College of Science and Technology, South Kensington, S.W.7; General Organic Chemistry.

The next meeting of the Committee is to be held on December 19, and it is hoped that prior to this date sufficient information will be in the hands of each Convenor to enable him to make a close estimate of the amount of space he will require and the expenses which will be incurred in his section. It is essential that this date be adhered to, if the subsequent work is to be efficiently carried out.

The idea of having standard specimen bottles has been abandoned, and specimens will be shown in exhibitors' own bottles, except in special circumstances. The importance of the Scientific Exhibits has already been well recognised by the technical press, and I am, therefore, encouraged to hope that the widest publicity may be given to the details of the arrangements which have already been made.—Yours, &c.,

W. J. V. Woolcock.

The Association of British Chemical Manufacturers.

166, *Piccadilly, London, W.*1.

November 21, 1923.

RED SULPHIDE DYES.

To the Editors of The Chemical News.

Sirs,—In a recent paper communicated to this Journal on the subject of sulphur dyes, the author remarked that sulphide dyes are known in every colour but red (*The Chemical News*, 1923, CXXVII.). The recent research of Watson and Dutt on the subject of these dyes deserves, in view of this, some mention. The first paper on this subject communicated to *The Chemical Society* in 1922, expressed the view that the lack of fastness of these dyes was due to the fact that they contained ordinary auxochromes, such as amino or hydroxyl groups, as well as mercaptan groups, and the presence of these ordinary auxochromes caused the dyeings to be stripped to a certain extent by acids or alkalis. Some substances were therefore prepared containing chromophores and mercaptan groups, but no auxochromes. Thus 4 benzeneacinaphthylmercaptan was found to be soluble in sodium sulphide, but only to dye in light brownish shades. Despite this it was hoped that the mercaptan derivatives of the various groups might prove more valuable red sulphide dyes than the compounds prepared by various previous workers. But the various new compounds of the azine, oxazine, phthalein, nitroso and acridine groups all failed for one reason or another. Thus 2-amino-8-thiol-10-phenyl phenazonium hydroxide,

though a sulphide dye, was found to dye only in dull violet shades; 3-amino-7-dimethylamino-4-thiolphenazine only to give red-brown shades very sensitive to acids an dalkalis; 9-dimethylamino-2-thiol-3-phenoxazone to be soluble in sodium sulphide, but only to give blue shades. The following compounds were prepared:—

Ethyl 4 Benzeneazo 1 naphthyl xanthate,
4 Benzeneazo 1 naphthyl mercaptan,
pp'p" trithioltriphenylcarbinol,
2 amino 8· thiol 10 phenylphenazonium Hydroxide,
3 Amino 7 dimethylamino 4 thiolphenazine,
9 Dimethylamino 2 thiol 3 phenoxazone,
Dithiolfluorescein,
Dinitrosothiolresorcinol, and
2:2':4:4' Tetra amino 5:5' dithioldiphenylmethane.

Yours, &c.,
R. F. HUNTER, F.C.S.
Highbury, N.E.

NOTICES OF BOOKS.

Recent Developments in Atomic Theory, by LEO GRAETZ (Professor of Physics in the University of Munich), Translated from the German by G. BARR. Pp. XI. + 174 (with index). 1923. Messrs. Methuen & Co., Ltd., 36, Essex Street, W.C.2. 9s. net.

This is a welcome book, coming just at the time when so much interest is developing in connection with atomic theories.

The book opens on somewhat conventional lines, dealing with molecules and atoms. In passing we notice the statement that "Molecules are the units of structure of compounds." This is really only a half truth, and there are several such half truths noticeable in the book. It has been experimentally demonstrated that in certain crystals, for example, the atom or molecule loses its identity, so that the attempt to sub-divide all matter by hard and fast degrees breaks down in this type of case.

The book is, however, strong on the physical, or more particularly the electrical, side, and the chapter on atoms and ions is excellent.

The usual statement that Helmholtz (1881) was the first to draw important conclusions from Faraday's experiments involving the conception of atomic or molecular electricity, appears in this book; but some time prior to 1881 the idea of molecular electricity was known. Still we do not wish in any way to minimise the value of Helmholtz's suggestions.

The statement appears on p. 29 that "electricity behaves like a special chemical element, whose atoms combine with those of the other known elements to form ions." Hydrogen without its electron would be an ion, so that this statement is again in the nature of a half truth according to recent views. These should be corrected in the second edition.

Disintegration of atoms, X-ray spectra, line spectra, Bohr's model, and the "decomposition" of nuclei are dealt with clearly.

Balmer's law is represented in a very clear manner, which points to the desirability of physicists making their equations attractive in appearance to the lay mind and also businesslike for quick appreciation.

The table of isotopes on p. 88, head of third column, should read II. The system of closed branching, see p. 65, as is used in Germany, is adopted, notwithstanding the International Committee's Report.

The usual error of tacitly accrediting Aston with the discovery of the two neon isotopes is made in this book. As a matter of fact, Sir J. J. Thomson was the first definitely to isolate the component isotopes of neon by means of his positive rays; but we have few impartial historians in science as yet.

The book is well illustrated, while the translator is to be congratulated on the lucidity of his style.

The A.B.C. of Atoms, by BERTRAND RUSSELL, F.R.S. Pp. 175 (no index). 1923. Messrs. George Routledge & Sons, Ltd., Broadway House, 68-74, Carter Lane, E.C.4. 4s. 6d. net.

This little book, as a popular exposition of the atom, is well worth perusal by all interested in the subject, but there are some statements which should be corrected in the second edition. For example, on page 13, the end-product of disintegration is referred to as a lead "of a sort." As we all know, it is *lead* in every sense of the chemical and physical meaning we attach to common lead. On page 62 it is stated that the atom has least energy when the orbit is smallest. This does not necessarily follow. What energy the electron retains, and what energy the electron absorbs and gives out are two quantities that should not be confused with each other. On p. 129 the following appears: "When two elements have the same atomic number they are

called 'isotopes.'" Chlorine 35 and chlorine 37 have the common atomic number 17, but isotope 35 is not one element and isotope 37 another. The word element in this case embraces all atoms, whatever their difference in atomic weight may be. The above statement was made in connection with radio-activity, when two differently-named elements may be isotopically alike, but such statements are not satisfactory.

The book, however, abounds in many happy statements, and it should have a wide circle of readers. The absence of the usual diagrams and an index are a disadvantage to a book of this kind.

BOOKS RECEIVED.

Industrial Filtration, by Arthur Wright, M.E. Pp. X. + 336. Vol. I., 1923. The Chemical Catalog Co., Inc., 19, East 24th Street, New York, U.S.A. $5.00.

Kolloide in der-Technik, von Dr. Raphael Ed. Liesegang. Pp. 157. 1923. Herr Theodor Steinkopff. Residenzstrasse 12b, Dresden and Leipzig. 3s. 6d.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

28156—Bachalard, G.—Preparation of sulphuric anhydride. Nov. 8.

17804—Coppee, E.—Manufacture of pure alcohol. Nov. 5.

28008—Dreyfus, H.—Manufacture of cellulose derivatives. Nov. 7.

2774—Koppers Co.—Manufacture of alkali sulphides from thiosulphates. Nov. 5.

Specification Published this Week.

195345—Holzverkohlungs-Industrie Akt-Ges.—Process for the chlorination of methane.

Abstract Published this Week.

204223—Lead arsenate.—McDougall, I., of 66, Port Street, and Howles, F., of Glenluce, Water Park Road, Broughton Park, both in Manchester.

Lead arsenate is obtained by reacting with arsenic acid upon a colloidal solution of lead oxide in water, aqueous solution, or other suitable dispersion medium, preferably at a raised temperature. The arsenate precipitates in a finely divided form. An example describes the production of the arsenate PbHAsO in this manner, the colloidalising of the lead oxide in water being effected in a Plauson mill, steam being passed through the jacket of the mill so as to raise the temperature to 80-100° C. The arsenic acid is run into the mill and the reaction is effected in a few minutes.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

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THE CHEMICAL NEWS,

VOL. CXXVII. No. 3221.

THE SEPARATION OF HAFNIUM FROM ZIRCONIUM.

By G. Hevesy and V. Thal Jantzen.

In the issue of *The Chemical News* dated July 20, 1923 (Vol. CXXVII., p. 33), a short account of the methods generally used in the separation of hafnium from zirconium was given. We have received requests from different sources to give a more complete account of our experimental work, and of the efficiency of the methods employed. In deference to these requests we propose to give, in the present paper, a detailed description of the preparation of hafnium by the double fluoride method.

When working with larger amounts of minerals, we abandoned the method originally used, of preparing and crystallising the potassium zirconium fluoride. Under such conditions the method of crystallisation of the corresponding ammonium salt was found more suitable. This compound possesses a solubility[1] about ten times as large as that of the potassium salt. Moreover, it is very stable, it can be crystallised out in porcelain dishes without these showing any indication of having been attacked, and it crystallises in beautiful crystals.

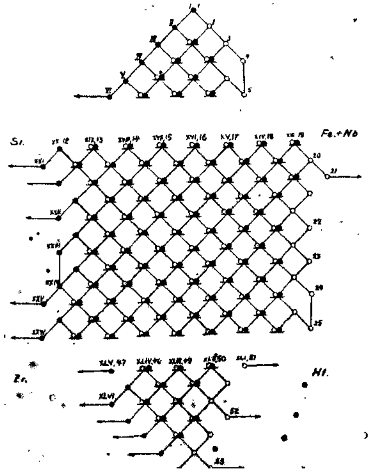
To prepare this compound, the pulverised mineral is first treated with hot concentrated hydrochloric acid, to remove the iron and other soluble impurities present, and the mineral which has been thus purified is then mixed in small portions with fused acid ammonium fluoride in a large platinum crucible.

Using the zirconium mineral alvite, it was found that a part of its zirconium and hafnium content is soluble in concentrated hydrochloric acid. In view of this, the preparation of the double salt of ammonium was carried out in two parts: (*a*) The fraction insoluble in hydrochloric acid was fused with about four times its weight of acid ammonium fluoride; (*b*) the hydrochloric acid solution was evaporated to dryness to render the silica insoluble, and the $ZrOCl_2$ + $HfOCl_2$ was extracted with cold water, purified from iron and other impurities by crystallisation, and converted into ammonium zirconium and ammonium hafnium fluorides respectively.

In what follows, we shall give a detailed description of the treatment of the portion (*a*).

After the mineral has been fused with acid ammonium fluoride, it is extracted repeatedly with boiling water, which dissolves zirconium, hafnium, titanium, niobium, tantalum, vanadium, germanium, iron, and manganese, some of which are present only in very minute quantities, and very considerable amounts of ammonium silicon fluoride. Thorium, the higher homologue of hafnium, and also the rare earth elements present, remain insoluble, together with unattacked mineral and insoluble zirconium and hafnium fluoride compounds, such a sodium zirconium fluoride.

On cooling down the solution, denoted in the diagram by I.1, the greatest part of the double fluorides crystallises, supplying the crystals indicated by II.1, and a mother liquor I.2. The next step consists in dissolving II.1 in boiling water, from which on cooling, the crystals III.1 and the mother liquor II.2, are obtained. The mother liquor I.2 is now partly evaporated, and on cooling it supplies the crystals II.2, together with the mother liquor I.3. The mother liquor II.2 is used to dissolve the crystals II.2. The successive steps in the crystallisation are indicated in the following diagram, the black dots representing crystals and the circles mother liquors:—



DESCRIPTIVE TABLE OF CRYSTALS REMOVED.

Fraction.	Total Weight of Double Fluorides.	% of ZrO_2.	% of HfO_2 in ZrO_2.
VI,1	848	0.5	0.5
VIII,2	415		
XIII,4	310		
XVI,6	190		
XVII,7	120		
XVII,8	165	1.6	2.5
XVIII,9	134		
XXI,12	117		
XXI,13	198		
XXII,14	101		
XXV,16	91	11.2	<2
XXVI,17	54		
XXVI,18	84		
XXVII,19	35		
XXVIII,20	35	13	
XXIX,21	39		
XXIX,22	56		
XXX,23	79		
XXXI,24	130		
XXXII,25	124	36	<2
XXXIII,26	88		
XXXIV,27	93		
XXXV,28	74		
XXXV,29	90	c.50	<2
XXXVI,30	45		
XXXVI,31	97		
XXXVII,32	41		<2
XXXVIII,33	32		
XXXVIII,34	33		
XXXVIII,35	42		
XXXVIII,36	56		<2
XXXVIII,37	98		
XXXIX,38	25		
XXXIX,39	25		
XXXIX,40	40		3
XL,41	12.4		
XLI,42	21.4		
XLI,43	13.2		2
XLII,44	14.2		
XLIII,45	7.6		9
XLIV,46	6.5		
XLV,47	14.4		15
XLVI,48	12.2		
XLVI,49	15.9		25
XLVI,50	12.1		
XLVI,51	13.4		35
XLVI,52	15.9		

The results of crystallisation were checked by first determining the sum-total of zirconium, plus hafnium, plus traces of impurity present. This was performed by weighing the oxides obtained by treatment of the double fluoride with concentrated sulphuric acid, and igniting. On the other hand, the hafnium content was determined by using the methods of quantitative X-ray spectroscopy, as described by D. Coster in *The Chemical News*, dated August 3, 1923 (CXXVII., pp. 65-70).

As shown in the accompanying table, fractions first removed contained practically only ammonium silicon fluoride. As we proceed downwards in the table, the amount of this compound diminished, and the fraction XXXV/29 is practically pure zirconium salt, with about 2 per cent. hafnium content.

Not until fraction XLIII/45 has been reached does the hafnium content begin to increase in the removed crystal fractions considerably; this fraction contains 9 per cent. of hafnium.

Whereas the major part of the crystal fractions obtained by the process described was found to be practically free from hafnium, the bulk of the hafnium was present in high concentration in the mother liquors. The fraction of these which was first removed from the system was V.11. It consisted chiefly of highly soluble impurities such as the double fluorides of iron, manganese and niobium, and about 4 to 5 per cent. of hafnium salt. Fraction XIII/21 still contained about 10 per cent. of impurities, 20 per cent. of ZrO_2, and 70 per cent. of HfO_2. On the other hand, fraction XXXVI/48 revealed a *hafnium content of about 99 per cent.*, a zirconium content of not more than 1 per cent., traces of titanium, niobium and manganese, and very minute traces of vanadium and germanium. The existence of the elements present only in traces was detected by optical spectroscopy. Fraction XLI/51 contained 97.5 per cent., fraction XLIII/53 95 per cent., of hafnium.

When a mixture of hafnium and niobium double fluorides is heated carefully, and afterwards treated with boiling water and acid ammonium fluoride, only the hafnium salt dissolves. This method was repeatedly used to remove niobium from our preparations.

The elaborate work of 650 crystallisations was performed in order to extract in a concentrated form the major part of the hafnium present in the mineral.

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[1] *We propose to give a detailed account of the solubility measurements in a subsequent issue of "The Chemical News."*

Institute of Theoretical Physics,
Copenhagen University.
September, 1923.

ARE THE NATURAL GROUPINGS OF THE ELEMENTS AND THE SPECTRAL LINES OF HYDROGEN RELATED?

PART V.

BY F. H. LORING.

In developing this study—see *The Chemical News*, 1923 CXXVII., pp. 225, 257, 273, 290, 337—some further interesting features are brought into consideration; but before making deductions therefrom it will be necessary to acquaint the reader with a line of research of very considerable scientific importance. Moreover, the digressions here made have a direct bearing on the argument, and give support to it, as will be seen presently.

Prof. L. Vegard, in the *Philosophical Magazine* for October, 1923, contributes a paper entitled "The Constitution of the Upper Strata of the Atmosphere," in which he propounds a theory, based upon experiment, that in the higher regions of the earth's atmosphere, where the aurora curtain phenomenon is confined, clusters of nitrogen molecules, forming a sort of dust (crystals), exist.

It is, moreover, suggested that this dust is carried upwards and maintained at high atmospheric levels by reason of the electrically charged state of the particles, and that this charged state is due to a photo-electric effect arising from the incident rays, including ultra-violet light, of the sun. It will be remembered that ultra-violet light falling on substances causes the emission of electrons therefrom, leaving the substance positively charged. In this case, however, corpuscular rays from the sun may be involved, and, indeed, the magnetic field of the earth plays a part in these phenomena, and consequently the aurora is locally produced. The negative electric charge of the earth is supposed also to influence the auroral displays.

The spectrum lines of the aurora, in particular the famous green line, occurring at the altitude within which this phenomena

is observed, and a certain agreement between this spectrum and that of normal nitrogen, is advanced as good evidence that the aurora is due to the sun's rays impinging upon *solid* nitrogen particles. Electron rays are mentioned in this connection.

Prof. Vegard further suggests that it is these particles which give rise to optical scattering, so that the sky is rendered blue by reflected light. The twinkling observed in the case of fixed stars is attributed to the same fundamental cause. Prof. Vegard's paper is summarised at the conclusion of this section.

Of immediate interest to the present argument, however, is Vegard's view that the bending of Hertz waves so that they conform to the general curvature of the earth is due to the state of affairs arising from the layer of charged nitrogen crystals surrounding the earth as a dust layer situated at a high altitude.

The problem of the bending or reflecting downwards of the electric waves has been under discussion for many years; and Prof. Fessenden and Dr. Elihu Thomson have contributed towards its solution, the former supporting the view that at high altitudes, beginning at the lower termination of the auroral draperies, there were ionised gas particles, this ionisation being induced by direct rays from the sun; while the latter advocated a gliding theory, the waves being as it were attached to the earth so as to follow its contour, much in the same way as electric waves become attached to conducting wires. The layer of ionised gas, supposed to act as a deflecting medium, has been mathematically studied by Professors Fleming, Eccles, and others, this layer being known as the Heaviside layer owing to Heaviside's mathematical work in general in connection with such matters.

Thus it will be seen that there are three theories involved in the elucidation of this phenomenon, which arose from researches in connection with wireless work. These may be referred to as (1) *the gliding theory*, (2) *the ionised gas Heaviside layer theory*, (3) *the nitrogen crystals Heaviside layer theory*.

Now, Prof. Vegard shows that the gas theory is untenable; that is to say, ionised *gas* will not account for the spectrum obtained, and it is therefore supposed that the bombardment of the nitrogen *crystals* by corpuscular rays from the sun will account [for t]he peculiarity of the spectrum of the aurora draperies observed at the lower edge and at the highest region.

It frequently happens that when theories are first established, there are phenomena involved which coincide in their effects so that the theory is not the whole truth, but only an overlaid truth, which would become modified when more knowledge is brought to bear upon the subject.

In the case of the Heaviside layer, it is quite possible that the radiation may tend itself to describe what might be termed a ground orbit round the earth. This idea is made possible from the following considerations: In Parts I. and II. of this paper it has been shown that the first five Balmer emission lines of the hydrogen atom are linearly related to five natural groups and groupings of the elements in the periodic table; and in Part III. of this series, that these same values are in close agreement with the spacing of five consecutive planets (regarding the asteroids as collectively one planet); and in Part IV., also of this series, that the many-lines spectrum of the hydrogen molecule accords very well in its intensity distribution with the distribution of the asteroids.

To be able to pass in this manner from the smallest known phenomenon to one on the huge scale of the planetary system seems to involve a *place principle* of universal significance, which gives to space round all bodies a controlling feature of its own, quite apart from the mass magnitudes of the outer bodies concerned. If this is true, as seems to be the case, then it is only a natural step to consider whether radiation will not, under suitable conditions, describe closed orbits round bodies including atomic nuclei. This is, of course, a new idea as applied to the atom, as it had been supposed that radiation could only travel in straight lines through space, though Einstein's theory shows that light from the stars is slightly bent in its course past the sun, and Hertz-wave experiments seem to show bending round bodies. Just what the conditions are is, of course, speculation, but the strong fields round atoms, or rather round atomic nuclei, and presumably also the positively charged particles in the Heaviside layer, may account for the interpretation of the phenomena indicated.

If there is a germ of truth in this idea, then it may be that all the atomic orbits are not due to electrons actually describing them; but that they are described by pure radiation, while the electron as the opera-

tor may only vibrate and pass from one practically fixed radial abode to another, linear or radial radiation being given out when the orbit is broken or detached. The electron, on this view gives rise to the orbital radiation, but to all intents and purposes the electron is stationary, so that the Lewis-Langmuir theory can be retained in its present form with, of course, modifications in detail, as has been made by recent investigators. In the case of the Bohr orbits, these are, on this view, electrodynamically equivalent to an electron describing such orbits.

Considering the stability of the electron in its stationary position outside the nuclear part of the atom, it is quite possible to regard the electric fields involved as so disposed that the electrons accommodate the most electric lines when they are at places a little distant from the nucleus, just as an iron disc will not remain face down on the flat face of a magnet, for the simple reason that in its upright or edge position it can accommodate more magnetic lines of force. It must be remembered that the lines of electric force in the atom are reduced to their lower numerical limit in joining up with one electron, and on this account something in the nature of a limiting condition must prevail. This is discussed in the writer's "The Chemical Elements," Chapter IX.; see also page 161.

Considering now Planck's radiation theory involving energy quanta, this would not be interpreted in quite the same way as at present, since the quanta would merely be apportionments of closed radiations (orbits), and open radiations, so to speak (see Notes to follow). The closed radiation is atomic or quantum like, while the open radiation behaves in accord with the undulatory theory of light. On this view a model could be constructed showing the various quantum groups emitted as the various orbital-radiations are broken or detached, which would accord with Planck's energy equation. See the writer's "The Chemical Elements," page 82.

SUMMARIES.

The Heaviside layer, which is supposed to cause Hertz waves to conform to the general contour of the earth, is discussed in the light of Vegard's theory that the higher regions of the atmosphere contain minute positively charged crystals of nitrogen, but it is suggested that these waves may tend to describe a ground orbit round the earth, because orbital phenomena do not depend upon the mass of the circulating body, as is evident from the fact that the five Balmer lines of the hydrogen atom are linearly related to the groupings of the elements in the periodic table, to the radial positions of five consecutive planets of the solar system, and the many-lines spectrum of molecular hydrogen is possibly related to the distribution of the asteroids. This leads to the idea that the Bohr orbits are closed-radiation orbits, which only give rise to emission lines when the electron is displaced so as to allow the radiation to expand as a radially-directed wave, which conforms in its behaviour after leaving the atom with the undulatory theory of light. Having thus practically stationary electrons, the Lewis-Langmuir theory may be a true one. The quantum theory is then an apportionment of open and closed radiations, for each closed element of radiation is of the nature of a quantum. The closed radiation being mathematically equivalent to a moving electron, while the electron may only vibrate. Is it not possible for the laws established by Bohr and others to be retained with only a slight alteration in their interpretation, as will be seen by considering the action of a model liberating various closed orbits of radiation which become "linear" or "radial" radiations?

Vegard's summary of his paper follows here. It contains much of general interest.

1.—Photographs of auroral spectra corresponding to different altitudes have been obtained.

2.—The intensity of the green line relative to that of the nitrogen bands does not increase as we pass upwards, but shows a small but noticeable diminntion.

3.—The observations show that the green line cannot be due to any light elementary gas, such as H, He, or the hypothetical geocoronium.

4.—The green line must originate from nitrogen or from some substance attached in some way to nitrogen. Arguments are given for considering the latter possibility to be excluded.

5.—Independent of any hypothesis with regard to the origin of the green line, observations show that nitrogen is a prominent component of the atmosphere to its very upper limits.

6.—To explain this fact we must either assume for the auroral region an increasing temperature amounting to several hundred degrees centigrade, or we must assume that nitrogen is kept up by the effect of electric forces. Various circumstances seem to exclude the first possibility.

7.—The differential equation for the variation of density in an electrified atmosphere has been found, but its solution has not been carried farther because some simple calculations have shown that a highly electrified upper *gas* layer cannot exist.

8.—If we adhere to the hypothesis that nitrogen is driven upwards by electric forces we are led to the assumption that the nitrogen in the upper layer is condensed into small crystal particles, which are then electrified through the photo-electric effect of the sun's rays of very short wave-lengths.

9.—The auroral spectrum should be produced when electric rays from the sun penetrate into the layer of nitrogen dust.

10.—The colour changes of the auroræ are explained through disintegration or evaporation of the dust particles caused by the cosmic electric rays.

11.—Our view with regard to the physical state of the atmosphere gives a simple explanation of the following phenomena:—

(*a*) The sudden change of colours along the track of a meteor.

(*b*) The increase of the maximum height of auroral rays as we pass towards lower latitudes.

(*c*) The zodiacal light.

(*d*) The blue colour of the sky.

(*e*) The twinkling of fixed stars and the absence of twinkling in the case of planets.

(*f*) The reflection of electric waves and sound waves from the upper layer of the atmosphere.

(*g*) The secondary auroral phenomena.

(*h*) The absence of an upper layer consisting of the light gases, hydrogen and helium.

INDIGOID DYESTUFFS.

PART I.

By R. F. HUNTER, F.C.S.

(*Continued from Page* 341.)

Bayer's synthesis of 1880 was improved two years later by his synthesis from o.nitro benzaldehyde. o-Nitrobenzaldehyde was condensed with acetone in the presence of alkalis to o nitro phenyl lactone methyl ketone. This, on treatment with alkalis, eliminated water and acetic acid passing into indigo. The hydroxy ketone, on dehydration with acetic anhydride, yielded o nitro styrl methyl ketone which, with alkalis, gave indigo.

These, however, were not of commercial value, since toluene was the starting material. In 1890 Heumann published a new synthesis of indigo, the starting materials of which were benzene and acetic acid. Aniline was obtained from benzene and monochloracetic acid from acetic acid, and these were condensed to give phenylglycine. This, on fusion with alkalis at 300° or above, eliminated water, giving indoxyl. This, by atmospheric oxidation, gave indigo. the yield, however, was bad. Three years later accomplished the synthesis in extensive use to-day, *viz.*, the anthranilic acid synthesis. Anthranilic acid condensed with chloracetic acid yields phenyl glycine o carboxylic acid. This, on alkali fusion, gives indoxylic acid, and this, on oxidation, gives indigo. Seven years later the process was being worked on a commercial scale by the Badische anilin and Soda Fabrik. The trouble was, of course, to obtain a suitable source of anthranilic acid; naphthalene provided this. Naphthalene being oxidised to phthalic acid by means of sulphuric acid and mercury, this being converted into its anhydride, and thence to the imide by means of sulphuric acid and mercury, this being converted into its anhydride and thence to the imide by means of ammonia, and this, on treatment with caustic soda and chlorine, giving anthranilic acid. The process of condensation has been recently modified, the acids being condensed in the form of their alkali salts. A still better modification is to treat the sodium salt of anthranilic acid with sodium bisulphite compound of formaldehyde and with sodium cyanide; a nitrite is obtained which hydrolyses to phenyl glycine carboxylic acid.

A synthesis allied to Heuman's consists of condensing aniline with ethylene chlorohydrin and fusing condensation product with caustic soda, the melt, on oxidation, yielding indigo. Another synthesis is by heating glycollide with aniline at 200°, the product being glycollanilide. This, on alkali fusion, gives a mixture of indoxyl and indoxylic acid, and this, on oxidation, yields indigo.

Sandemeyer's synthesis is worthy of note. Aniline is converted into thio carbanilide. This, warmed with KCN and white lead in aqueous alcohol at 60°, yields hydrocyano diphenyl carbimide. This, on treatment with Am_2S for two days at 30° proceeds to the thioamide. This, with H_2SO_4 at 110° gives isatin and anilide. This, on reduction with Am_2S, yields, firstly, thio isatin, and finally indigo. Another synthesis by the

same author depends on the preparation of isatin anilide by action of concentrated H_2SO_4 on amidine obtained by condensation of aniline and chloroloxime.

Among the other syntheses of indigo, we might mention Nencki's synthesis of indigo by action of ozone on indole. Camp's synthesis from o nitro acetophenone. Homolka's preparation from o amino aceto phenone, which on heating at 200° with sulphur in a high boiling solvent, eliminated hydrogen as H_2S giving indigo. Simoni's synthesis from dianilinomaleic acid from aniline and dibromomaleic acid is worthy of note.

Bauer's preparation from oxanilide is likewise of interest, and Reissert prepared indigo in the following way: o nitro toluene was condensed with ethyl oxalate in presence of sodium ethoxide to give ethyl o nitro phenyl pyruvate, which on reduction gave N hydroxy indole carboxylic acid, which he oxidised to indigo. Indole, the starting point of Madelung's preparation, has been synthesised in a number of ways. o nitro w chloro styrene obtained by bleaching powder on o nitro cinnamic acid is reduced to aminochloro compound. This, on heating with sodium ethoxide, gives indole: o nitro benzaldehyde can be converted into o aminobenzaldehyde, this to o aminobenzaldoxime, and this to corresponding o aldehyde glycine; this is converted into indole by ring closure brought about by heating first with acetic anhydride and anhydrous sodium acetate, and then with aqueous alkalis.

Indole treated with amyl nitrite and sodium ethoxide gives isonitroso indole. This can be reduced to aminoindole, this oxidised to indigo doimine, and this hydrolysed by boiling HCl to indigo.

It is now proposed to deal with some of the derivatives and analogues of indigo, and it is further proposed to use the classification used by Thorpe and Ingold in their recent work on Vat Dyestuffs. The first group of compounds to be considered are the halogen derivatives of indigo. The following compounds habe been described:

5 Monochloro indigo;
5:5′ dichloro indigo;
5:7:5′ Thichloro indigo;
5:7:5′:7′ Tetrachloro indigo;
5 Monobromoindigo;
5:5′ Dibromo indigo;
5:7:5′ Tribromo indigo;
5:7:5′:7′ Tetra bromo indigo;
4:5:7:5′:7′ Penta bromo indigo;
4:5:7:4′:5′:7′ Hexa bromo indigo;
5 Chloro 5′ bromo indigo;
5 Chloro 7:5′ dibromo indigo;
5 Chloro 7:5′:7′ tri bromo indigo;
5:7:5′ Trichloro 7′ bromo indigo;
4:4′ Dibromo indigo;
5:5′ Dibromo indigo;
6:6′ Dibromo indigo;
7:7′ Dibromo indigo;
5:7:4:7′ Tetra chloro indigo;
5:6:5′:6′ Tetra chloro indigo;
Octa chloro indigo.
Octa bromo indigo;
5:7 Dibromo indigo;
6:6′ Dichloro indigo.

The following nitro and amino compounds have been described:—

5:5′ Diamino indigo;
6:6′ Dinitro indigo;
6:6′ Diamino indigo;
6:6′ Diamino 5:7:5′:7′ tetra bromo indigo.

Among the sulphonic and carboxylic acid derivatives we might mention:—

Indigo 5 mono sulphonic acid;
Indigo 5:5′ disulphonic acid;
Indigo 5:5:7′ tri sulphonic acid;
Indigo 4:4′ dicarboxylic acid.

As hydroxy and methoxy derivatibes, we have:—

4:4′ Dichloro 7:7′ dihydroxy indigo;
4:4′:6:6′ Tetra chloro 7:7′ dihydroxy indigo;
5:5′ dihydroxy indigo;
7:7′ Dihydroxy indigo;
4:4′ Dimethoxy indigo;
5:5′ Dimethoxy indigo.
6:6′ Dimethoxy indigo; and the
7:7′ Dimethoxy indigo.

As homologues of indigo there are:—

7:7′ Dimethyl indigo;
α Naphthalene indigo; and
β Naphthalene indigo.

A diphenyl derivative has recently bee[n] prepared:—

$$NH_2\cdot C_6H_4\cdot C_6H_3 < \begin{matrix} CO \\ NH \end{matrix} > C = C < \begin{matrix} NH \\ CO \end{matrix} > C_6H_3\cdot C_6H_4\cdot NH_2$$

5:5′ Di p amino phenyl indigo.

The Royal College of Science, South Kensington, S.W.7. *September, 1923.*

WHAT CHEMISTRY SHALL BE TAUGHT IN HIGH SCHOOL AND HOW IT SHALL BE CORRELATED WITH COLLEGE CHEMISTRY.

By Louis W. Mattern.

Chemical Department McKinley Technical High School, Washington, D.C.

(Abridged from the "School Science and Mathematics," Vol. XXIII., No. 7, October, 1923.)

(Continued from Page 349.)

At the very beginning, the high school student in chemistry should be brought in full harmony with the fact that chemistry is guided by fundamental principles, or laws, which find a great variety of material expressions, and is not a mere memorisation of unrelated, isolated facts, and bugbear equations. Professor Remsen's statement to a class of students in chemistry might well be a motto for all high school students in chemistry: "Those who are looking for anything else than a clarification of fundamental principles need not stop here." All experiments should lead to the development of fundamental principles, and their application in experiments having problems to solve, and not merely entertaining tests, revealing no principles nor relationships. Too often, students have been pushed into the applications of chemistry without a knowledge of those fundamental principles of which the applications are but the expressions, and thus in the wild rush to be practical, the very thing that will produce practical results has been omitted. As time permits, many applications should be presented, but always illustrative of fundamental principles. Principles and applications are the combinations that will produce far more interest and permanent benefit than short industrial and applied courses in chemistry without the proper foundation of fundamental principles. George W. Walker, of the Hupp Motor Car Corporation, even goes so far as to state: "*For the best training and education of the individual coemist, the first and most important thing is to forget all about industry,*" and, "*A student who intends to make a life work of chemistry should study it from the standpoint of a scientist rather than the standpoint of a factory manager.*"

The chief chemist of one of the leading scientific chemical commercial laboratories made this statement: "A working knowledge of fundamental principles, rather than *routine ability alone, should be emphasised* in the training of a successful chemist." William C. Ruediger states: "The person who *understands the theory underlying a line of activity* can see the reasons for modifications and advances and, having a basis for assimilation, can adjust himself accordingly." I am sure that college professors of chemistry will agree that a firm grasp of certain fundamentals should be given in the chemistry of high schools, because they are essential for the solution of the many important problems in the ever widening field of chemistry.

The ability to make a correct report, either written or oral, of laboratory work, seems like too small a matter to mention at this time, but it is exceedingly important. The high school student in chemistry should ptssess this ability before continuing his collegiate chemistry, when he is too much engrossed with what seems, to him, to be weightier matters. The Chemical Engineering Education Conference "regards English as one of its most effective tools," and recommends "a special course in report writing and the oral presentation of projects." The haste to cover ground in a limited space of laboratory time has often resulted in abbreviating laboratory records, until they are simply answers to questions. The record of high school chemical experiments should contain clear cut, accurate statements of the purpose, operation, observations, based on the operation, and conclusions drawn from the observations. The conclusion should be the goal of the purpose, and between these the logical steps of operation and observation should be stated. All should be written in the student's own language, except the purpose. The repetition of this at the experiment table as soon as the experiment is performed will fix habit. It is just as important to know the conditions under which observations were made as it is to know the observations. Writing them both serves to unite and fix *this important combination in the student's* mind, as well as to acquaint him with a *method of making records that will be of service in the further study of chemistry.*

Plainly, if the high school students in chemistry are to possess in a marked degree the ability to observe, have a clear working knowlefige of certain fundamental principles, and can make good clear complete

records of experimental work, then the high school teacher of chemistry must not be a high pressure speed artist, driving on the highways to college chemistry, for the desire to cover too much ground is dangerous. The high school is distinctively a place for the development of those three things, with the paramount virtue of thoroughness. Again, too much speed in high school chemistry is detrimental to the all-important matters of relationships and generalisations. Isolated facts must be co-ordinated into a system, if they are to have power. It is not enough to know, for example, that sodium chloride and sodium nitrate will produce, respectively, hydrogen chloride and hydrogen nitrate, but that, in general, all chlorides and all nitrates behave in a similar manner; or that carbon not only reduces copper oxide, but acts on many other oxides in the same way.

How might any view be correlated with college chemistry and college chemistry with the high school view? Just as the Society for the Promotion of Engineering Education, and the National Engineering Societies and the National Committee on Mathematics, appointed committees which have recently made reports on the improvement of education in their respective branches, so I would suggest that the proper officers of the American Chemical Society appoint a nucleus committee, and this committee enlarge its number to include a sufficient representation. This committee should be a clearing house of the best information obtainable, and make a comprehensive study of how to improve education, covered by high schools, and articulate it with collegiate chemistry, and make a report of the same to the American Chemical Society for its approval. Such a report would strengthen the central science of chemistry, which plays an important role in our individual, national, and international prosperity.

GENERAL NOTES.

HISTORY OF THE SPECTACLE TRADE.

At a meeting of the Optical Society, held at the Imperial College of Science and Technology, South Kensington, on Tuesday, November 27, 1923, Dr. M. von Rohr, of Jena, delivered the 1923 Thomas Young Oration. The date was the 123rd anniversary of the delivery by Thomas Young of his famous Bakerian Lecture, "On the Mechanism of the Eye." The subject of the oration was "Contributions to the history of the spectacle trade from the earliest times to Thomas Young's appearance."

The lecturer divided the subject chronologically into six parts, and detailed the work done by different nations. The first period, beginning in the 13th century, extends to the invention of printing, about 1448. Comparatively few spectacles were then in use, and our knowledge of their production, distribution and price is very limited. The second period, relating principally to the growth of the South German spectacle factories from about 1450 up to 1620, is much better known. Thanks mainly to an oculist (Dr. v. Pflugk, of Dresden), our knowledge of the statutes and trade customs is quite remarkable, and exact details as regards the outward appearance of the spectacles then in use, their construction, distribution, and prices are available. At about the same time Venice must have been another important centre of spectacle manufacture, but unfortunately our knowledge of the glasses produced there is deplorably deficient. We are aware that in the early days of the telescope (the Dutch form and the terrestrial telescope, both made of single, unachromatised lenses) Venetian craftsmen were supplying these instruments; but of Venetian spectacles proper only some casual hints are ascertainable. In both these centres, however, "near" spectacles (for reading and working) only were made. Notable developments took place in Spain from about 1560 up to 1710: distance-spectacles fastened to the head were worn everywhere, even in the highest circles of Spanish aristocracy. This we know, not only from certain French histories that are not free from satire and irony, but also from such incontestable relics as pictures, engravings, medals. There we find high Spanish dignitaries, including a Viceroy of Naples, represented with nose-spectacles. At this time also Spanish spectacles, which were held in position by threads over the ears, were introduced to China and Japan by Spanish Jesuits. Another chapter, devoted to the decline of the South German spectacle factories between 1620 and 1780 shows the development of the cheapest nose spectacles. The chief development in this direction occurred in Nürnberg, between about 1640 and 1740, in a clever an deffective manner;

it is only a pity that the makers' principal object was to turn out the greatest quantity of extremely cheap (and sufficiently nasty) goods. The last part of the lecture described the growth of the spectacle grinding optician, and related principally to the London opticians of the 18th century. The patent specifications have preserved exact data with regard to the aims and methods of these old craftsmen. The greater accuracy indispensable with achromatic objectives (invented by Chester Moor Hall in 1733 and put on the market by John Dolland after 1758) placed the London spectacle maker proper on a much better footing than his Nürnberg competitor working with bad tools and to a very small degree of accuracy.

THE PREPARATION OF PURE SILVER STIBIDE.

By Edward J. Weeks, M.Sc., F.C.S., and William V. Lloyd, B.Sc., F.C.S.

In a previous communication (*The Chemical News*, 1923, CXXVII., 319), one of us (E.J.W.) showed that silver stibide could be prepared by passing stibine into dilute silver nitrate in the cold. It has now been found possible to prepare this compound in the pure state in the following way.

Stibine is prepared electrolytically by reduction of a pure antimony cathode in N. sulphuric acid (Sand, Weeks and Worrell, *J.C.S.*, 1923, CXXIII., 456-470), and after being washed and dried it is passed through some half normal silver nitrate in the cold. Silver stibide is then deposited in the pure state. The silver was estimated in the following way:

The silver stibide was boiled with concentrated nitric aci dfor about half an hour and then concentrated hydrochloric acid was added and the whole further boiled for half an hour. The antimony went into solution and the silver was deposited as silver chloride. The solution was diluted, and the chloride estimated in the Gooch. The theoretical percentage of silver is 72.92 per cent., and the estimated amount was found to be 73.01 per cent.

The fact that the nitric acid produced by the action of the stibine on the silver nitrate does not oxidise the silver stibide as shown by H. Reckleben (*Ber.*, 1909, XLII., 1458-1464) is no doubt accounted for by the fact that in this method of preparation the whole action is conducted in an atmosphere of hydrogen produced from the antimony cathode.

Sir John Cass Institute, Aldgate.
November 10, 1923.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY OF ARTS.

On Monday, December 3, Cantor Lecture (1), entitled *Recent Progress in the Wool Industries*, was read by Aldred F. Barker, M.Sc., Professor of Textile Industries, the University, Leeds.

On Wednesday, December 5, at the Ordinary Meeting, a paper entitled *The Work of the Royal Botanic Gardens, Kew*, was read by Arthur William Hill, M.A., Sc.D., F.R.S., F.L.S., Director of the Royal Botanic Gardens, Kew. Prof. C. A. Seward, M.A., F.R.S., F.G.S., F.L.S., presided.

On Friday, December 7, at a meeting of the Indian Section, a paper entitled *The Archives of the Honourable East India Company*, will be read by William Foster, C.I.E., Historiographer, India Office. (Sir eGorge Birdwood Memorial Lecture.) The Right Hon. Viscount Peel, G.B.E., Secretary of State for India, will preside.

THE FARADAY SOCIETY.

General Discussion on "Electrode Reactions and Equilibria," November 26.

The Mechanism of the Reversible Electrode, by Eric H. Rideal.

One of the oldest unsolved problems in physical chemistry is the source of E.M.F. in the simple galvanic cell and the mechanism of its production. Ever since the investigations of Volta, opinion has swung to extremes, oscillating between the contact and the chemical theories. At the present time there are supporters of each view, whilst a centre party of opinion wishes to ascribe the observed potential differences to both effects.

For our purpose we must exclude all irreversible effects caused by film formation at the electrodes or alteration in concentration of the electrolytes at the electrode surfaces due to a difference in the rate of removal of the ions from the skin in contact with the electrode and the rate of supply by diffusion.

A close examination of the literature on the capillary electrometer may readily lead

to the conclusion that the problem of the factors influencing the surface tension of a curved mercury surface in contact with an electrolyte have not yet been solved. It is possible that the Quincke double layer has no objective existence, and that the interfacial electrification is the result of ionic adsorption. The data of Smith and others clearly point to both cationic and anionic adsorption, whilst the Lipmann curve may be as readily deduced from the Gibbs surface tension equation as from the hypothesis of a Quincke electric double layer.

Oxidation and Reduction Potentials of Organic Compounds, by EINAR BULMANN.

The affinity of organic chemical processes has only been measured in very few cases of distinct transformations. Since 1920 several investigations on affinity giving numerical values have been carried out on reduction-oxidation potentials, especially of the type quinone-hydroquinone. I have tried to study the reduction potentials of some few quinones in electrolytes with different hydrion concentration.

The quinhydrone, the quinone-quinhydrone, and the hydroquinone-quinhydrone electrodes were described, and an account was given of the reduction potentials of different quinones and of azo-compounds.

The Processes at the Mercury Dropping Cathode. Part I.—The Deposition of Metals, by JAROSLAV HEYROVSKY, D.SC., PH.D., Charles' University, Prague.

Experimental results have shown that a polarised drop of a mercury capillary cathode represents a reversible state of equilibrium. On each polarised drop instantly the number of ions is deposted sufficient to charge it by their solution tension to the balancing back E.M.F. The almost streamless condition of polarisation excludes the secondary effects of the current so far that the potentials at which ions are deposited from various concentrations change like the potentials of concentration cells with reversible metallic electrodes. Thus this arrangement allows an extension to the study of tri- or tetra-valent ionic concentration cells. Further, since the freshly deposited atoms are always in an active condition, the conclusion seems justified, that any retardation phenomena oberved in the deposition cannot be due to surface conditions, but must be rather sought in an imperfect ionic equilibrium of the solution (*e.g.*, in the case of arsenic).

This circumstance enables us also to decide whether some metallic compounds exist as a true or as a colloidal solution.

The applicability of this method is limited on one side by the most unnoble lithium deposition-potential at about -2.1 volts. from the normal calomel electrode, on the other it stretches to +0.2 volt, where the oxidation of mercury begins.

Finally it may be pointed out that the method can be equally adapted for the study of nonaqueous solutions (see Dr. Shikata's subsequent communication).

The Processes at the Mercury Dropping Cathode. Part II.—The Hydrogen Overpotential, by JAROSLAV HEYROVSKY, D.SC., PH.D., Charles' University, Prague.

The chief circumstance that allows us to follow the metallic deposition at the dropping mercury cathode up to cathodic polarisations over -2.0 volts (from the calomel electrode potential) is the high overpotential displayed at the dropping mercury.

The real value of the overpotential of hydrogen, *i.e.*, the potential at which bubble formation takes place referred to the hydrogen electrode in the same solution, is thus in normal hydrochloric acid above -0.9 volt (-1.2 from the calomel electrode); the overpotential in more dilute acids is still greater.

It seems as if the presence of hydrogen ions catalyses the production of hydrogen; probably because the more acidic solution exerts a stronger oxidising influence upon the diffusing gas, which is then more readily removed from the electrode.

However, before the increase due to the deposition of hydrogen is reached (below -1.0 volt) the dropping electrode behaves in the presence of hydrogen ions exactly as in neutral or alkaline solutions, indicating a similar state of polarisation equilibrium in the drop surface.

The experience with polarisation phenomena at the dropping mercury cathode leads necessarily to the view that only hydrogen atoms are electrochemically active at an overcharged electrode, its potential depending on the relatively very few hydrogen atoms present at the cathode; after the union to molecules the gas, which is far from being in equilibrium with the atoms, is electrochemically inactive and escapes.

The abnormally high overpotential at the dropping cathode is certainly largely due to the clean freshly formed mercury surface; however, the chief factor of the overpoten-

tial must not be sought in the ideal smoothness of the surface—as is sometimes believed—but rather in the cathode material itself.

The author suggests that ions of unnoble atoms, when depositing at the charged electrode below their deposition potential, pass instantly again into solution; the number of depositions is slightly greater than the number of atoms, which leave the surface, so that each atom stays only a very short instance at the surface. If now an electrode material, like mercury, has no affinity for hydrogen nor exerts any physical adhesion to keep the hydrogen atoms longer at its surface or absorbs them inside the metallic phase, the atoms of hydrogen stay too short a time to have sufficient chance to come closer together and to combine; only at very negative potentials, when their deposition is more dense, union to molecules can proceed. The molecules then freely diffuse off or collect into bubbles. If, however, the electrode is capable of absorbing to some extent the deposited atoms, and thus shields them against the dissolving action of the olution, the atoms have occasion to combine below the surface, and escaping as molecules affect in such cases the polish of the electrode.

Some influence of a real chemical hydride formation could explain disturbances sometimes encountered at the dropping cathode during electrolysis of calcium and lithium salts, which were due to occasional bubble formation at the mercury drop. The hydrogen here evolved might be due to the union of the deposited atoms Li + H or Ca + 2H to hydrides, which are well known to be highly unstable in water and would in the aqueous layer at once form molecular hydrogen.

Note on the Standardisation of the Sign of the Potential, by Prof. A. W. Porter, F.R.S.

Determination of the Affinity Constants of Bases by the Hydrogen and Quinhydrone Electrodes, by J. N. Pring, M.B.E., D.Sc.

A determination has been made of the hydrolysis and affinity constants of a number of amino bases in water and in acetone-water mixtures.

Both hydrolysis and affinity constants are affected by the nature of the solvent to an extent which it has not yet been possible to correlate with any other property such as dielectric constant.

With a few exceptions, bases which are arranged in order of decreasing basicity in water have the same order as a similar series in the other solvents employed.

A determination of the dissociation constant of water has been made in acetone-water mixtures. As in the case of the affinity constants of bases, the value of the dissociation of water falls rapidly with increasing acetone content.

The author expressed his indebtedness to Mr. G. M. Westrip and Mr. T. K. Brownson for their collaboration in this investigation.

Electrode Potentials in Non-Aqueous Solutions, by Emil Baur.

Only one single method is available for the determination of a single potential difference between an electrolyte and a metallically-conducting electrode. The method is based upon an evaluation of the electro-capillary curve of mercury. Investigating this curve, G. Lippmann showed that the surface tension of mercury passes through a maximum when the polarisation is gradually being raised. At this maximum the charge on the mercury, and hence potential of the mercury against the liquid with which it is in contact, must be zero. From this consideration Helmholtz and W. Ostwald concluded that the measurement of the potential required for attaining the maximum of the Lippmann curve, would determine the potential which is effective at the mercury electrode under examination in its polarisation. When, and in so far as, this potential is identical with the voltaic potential, *i.e.*, the change in free energy, under the conditions prevailing, of the transition of mercury into mercurous ion, it must be permissible to determine the voltaic potential with the aid of the maximum of the Lippmann curve.

It has subsequently become clear that the assumption of this equality is not always justifiable. When so-called capillar-active ions are being adsorbed at the phase-boundary, the double layer of ionic adsorption will be superposed upon the Nernst-Helmholtz double layer.

Recent measurements allow us to conclude that in the case of inorganic salts the interface potentials corresponding to the partition equilibrium will generally be of little significance, amounting, perhaps, to 1

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centivolt Consequently we can fix absolute values for the electrode potentials in any non-aqueous solutions.

Concentration Cells and Electrolysis of Sodium Ethoxide Solutions, by DR. MASUZO SHIKATA, Imperial University of Kyoto.

To investigate the mercury dropping electrode for the study of electrolysis in non-aqueous solutions, this method has been tested on sodium ethoxide solutions. The reason for selecting the ethoxide solutions was not only their simplicity of composition and preparation, but the lack of information on this subject.

The chief aim concerning the dropping mercury method was to show that the deposition of sodium into the mercury drops from ethoxide solutions proceeds reversibly. This can be proved by comparing the shifts of the current-voltage curves with the potentials of ordinary concentration cells with sodium amalgam electrodes.

According to Heyrovsky, the sudden increase of current observable from a certain potential of the polarised drop is due to the formation of a very dilute amalgam of a certain composition, which begins to diffuse into the interior of the drops. This amalgam then must have the same composition, whether coming from any aqueous or non-aqueous electrolysis.

Therefore, if we could refer the "deposition potentials" of the polarised drops in alcohol or water to the same sodium amalgam electrode, we should obtain in either case an identical potential difference.

The deposition of sodium from alcoholic ethoxide solutions at the dropping mercury cathode was found to proceed reversibly as in aqueous solutions.

The activities of sodium ions measured by concentration cells with sodium amalgam electrodes showed an abnormal increase in concentrated solutions.

Conductivities and vapour pressures of these solutions suggest this anomaly to be due to the diminution of solvation of sodium ions.

(*To be continued.*)

THE CHEMICAL SOCIETY.

ORDINARY SCIENTIFIC MEETING, THURSDAY, DECEMBER 6.

The following papers were read:—

The Additive Formation of Four-Membered Rings. Part III. *A System of Nomenclature for Heterocyclic Four-Membered Rings and the Formation and Properties of some Derivatives of β-Methylenedi-Iminoxide*, by C. K. INGOLD.

The Dependence of Polarisation-overvoltage on Hydroxyl and Hydrogen Ion Concentration. Part I. *Polarisation-overvoltage of an Antimony Cathode in Aqueous Alkaline Solution*, by H. J. S. SAND and E. J. WEEKS.

Stereoisomerism and Local Anæsthetic Action in the β-Eucaine Group. Resolution of β- and Iso-β-Eucaine, by H. KING.

β-Alizarin. An Isomeric Form of Alizarin, by A. GREEN.

The Isomerism of the Oximes. Part XV. *The Supposed Fourth Benzildioxime*, by O. L. BRADY and F. P. DUNN.

The Alternation in the Heats of Crystallisation of the Normal Monobasic Fatty Acids, by W. E. GARNER and F. C. RANDALL.

ROYAL INSTITUTION OF GREAT BRITAIN.

A general monthly meeting was held on December 3.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Relations between Damping and Speed in Wireless Reception, by L. B. TURNER, M.A.

The first part was devoted to an examination of the ordinary method of recorder working in wireless telegraph receivers, as affected by the damping of the receiver circuits. After a résumé of the significances of the decrement of any oscillatory system, its bearing on the possible speed of recording Morse signals is investigated. The quality (approach to correct Morse "shaping") is estimated from calculated curves of amplitude of oscillation set up in the receiver by the incoming dots and dashes constituting the letter "I." By comparing several such curves, a minimum practical value is found for the product of frequency and decrement and duration of Morse dot. The relation between speed of signalling and the requisite transmitter power is then investigated. Part I. concludes (Section 5) with a summary and discussion of the results arrived at.

An improved method of reception, called

"receiver curbing," was described and analysed. An estimate is made of the improvement obtainable, and practical circuits are given for putting the method into effect.

NOTICES OF BOOKS.

Systematic Organic Chemistry, by WILLIAM M. CUMMING, B.Sc., F.I.C., I. VANCE HOPPER, B.Sc., A.R.C.Sc.I., F.I.C., and T. SHERLOCK WHEELER, B.Sc., A.R.C.Sc.I., A.I.C. Pp. XXII. + 535. 1923. London: Constable & Co., 10-12, Orange Street, W.C.2. 25s. net.

Organic Chemistry has become so complex, abounding in complicated formulæ, and including long series of preparations and catalogues of constants and properties, that the task of writing a systematic practical volume, such as this, is very great.

The three authors have endeavoured to produce a complete laboratory guide for the up-to-date methods of preparation and estimation of organic compounds. The introductory chapters deal with general hints and practical information. The compounds are then studied in groups, and according to the linkings of the carbon atoms, *e.g.*, carbon to carbon, hydrogen to carbon, oxygen to carbon, etc. Aliphatic and aromatic bodies are discussed together in their systematic groups. Altogether, in this section, 178 reactions are studied, involving the description of 381 preparations. This is not all, however, since, in the chapters on dyes, drugs, electrolytic and miscellaneous preparations the number is brought up to nearly 500.

Many methods given in recent researches have been included.

There are nine chapters dealing with the various processes of qualitatively estimating different elements and radicals in various types of compounds; many of them are of very considerable technical and industrial importance. The last two chapters are concerned with the reagents and with qualitative tests.

Great care has evidently been taken in arranging the matter, which is very ably presented, and it would be out of place to make more than reference to the small omissions (*e.g.*, the alternative method of estimating the NO_2 group), which might have been incorporated in this very comprehensive volume.

The book should commend itself to those engaged in directing advanced organic laboratory work. It is the type of book specially suited for students reading for final examinations, and for post-graduate workers. J.G.F.D.

Practical Mathematical Analysis, by HORST VON SANDEN, translated by H. LEVY, M.A., D.Sc., F.R.S.E., Pp. XV. + 195. London: Methuen & Co., 36, Essex Street, W.C.2. 1923. Price 10s. 6d. net.

This translation on applied mathematical methods is of interest, since it bridges the gap between the theories and their practical applications. The methods are developed with the object of expressing the results in a numerical form.

In the preface, the author urges that the slide-rule should be made a subject of school study. An explanation of its principles would certainly enable the conception of a function and the relative limits of accuracy to be introduced with more ease.

The book is of interest to experimentalists in the various pure and applied sciences.

Landolt-Börnstein, Physikalisch-Chemische Tabellin. Funfte Umgearbeitete und vermehrte Auflage, herausgegeben von DR. W. A. ROTH und DR. K. SCHEEL. In zwei Bänden Berlin: Verlag von Julius Springer. 1923. £9 7s. 6d.

Eleven years have elapsed since the fourth edition of *Landolt-Börnstein* appeared.

During this period physics and chemistry have developed very considerably, adding data to the enormous amount already accumulated.

The new matter in the present edition includes chapters on Radioactivity, Spectrum Analysis, The Physics of the Atom, Crystal Structure, etc. Other sections have been enlarged, so that the work is a really remarkable achievement, reflecting great credit upon the authors and their collaborators.

The Journal of Scientific Instruments: Issued by the Institute of Physics, 10, Essex Street, Strand, London, W.C.2.

The first issue of this Journal, October, 1923, brings to our notice its purpose in describing methods for measurement and the

construction of instruments in connection with all branches of scientific work. This is the first publication of its kind in England, and we have much pleasure in heartily welcoming it as being a medium of great utility to the scientific worker.

Under the management of the Institute of Physics, and with the co-operation of the National Physical Laboratory, this monthly publication should become a medium of national value.

The Editorial Board is a strong one, including Sir R. T. Glazebrook, K.C.B., F.R.S., Sir J. J. Thomson, O.M., F.R.S., and others of eminence. The secretary, F. S. Spiers, O.B.E., B.Sc., may be communicated with in regard to all matters other than those customarily dealt with by the editor, such as MSS.

BOOKS RECEIVED.

Uses of Waste Materials, by Prof. Arturo Bruttini. Pp. XX. + 367. 1923. Messrs. P. S. King & Son, Ltd., Orchard House, 2 & 4, Great Smith St., Westminster. 12s. net.

Lead, by J. A. Smythe, Ph.D., D.Sc. Pp. VI. + 343. 1923. Messrs. Longmans, Green & Co., 39, Paternoster Row, E.C.4. 16s. net.

PUBLICATIONS RECEIVED.

The Royal Technical College, Glasgow, has just issued the Annual Report on the One Hundred and Twenty-seventh Session. It contains an account of the Studies pursued and the successes obtained, and also the general information to be found in College Calendars.

The publications and papers on research work carried out by investigators at the College indicate that there is great activity in the Chemical Department.

Report 1921-22, with the Supplement to the "Guide to the Experimental Plots," containing the yields per acre, etc., has just been isused by the Rothamsted Experimental Station, Harpenden, and may be obtained from the Secretary, price 2s. 6d.

The work done during the period under review is given, and there is a summary of the results of original investigations which have been published in various journals.

The report is a further striking indication of what can be achieved by the constant and continued application of science and scientific principles to crop production and cultivation.

The Department of Overseas Trade has issued, through H.M. Stationery Office, a *Report on the Economic Situation of the Netherlands East Indies, to June, 1923*, by H. A. N. Bluett, British Commercial Agent for the Netherlands East Indies, Batavia. 1923. Price 3s. net.

The report contains a general review of the trade of the Netherlands East Indies for the period, and indicates the prospects for the near future.

The fact that the Netherlands East Indies is a considerable consumer of chemicals and chemical manures is now fully realised by British manufacturers, and exports to this country from the United Kingdom have been well maintained.

For several of the principal lines consumed there is an increased import which has largely favoured Great Britain. Many home manufacturers previously not represented in this market have during the past two years established trade relations with leading importing firms, so that if our competitive prices are maintained there is now every indication that in future the United Kingdom will be the principal supplier of heavy chemicals.

In addition to heavy chemicals there is a good demand for refined chemicals, medicines, patent medicinal foods and photographic chemicals, also chemicals required for the manufacture of aerated waters, syrups and cordials.

Artificial Dyes and Paints.—The import of dyes, which are much needed for the batik industry, remains steady, although with the exception of synthetic indigo the imports for 1922 show a decrease on 1921. It should be noted, however, that stocks at the end of December, 1922, were much lower than at the beginning of that year, and as the present demand for the batik industry is good, it is expected that imports for the current year will show an increase on 1922.

Livingstone College *Annual Report*, 1922-23.

Chains for General Engineering Purposes. Price List. Hans Reynold, Ltd.

BULLETINS ISSUED BY THE DEPARTMENT OF THE INTERIOR, UNITED STATES GEOLOGICAL SURVEY.

Gold, Silver, Copper, Lead and Zinc in the Eastern States in 1922, by J. P. Dunlop. Pp. 77 + 14.

Bauxite and Aluminum in 1922, by James M. Hill. Pp. 87 + 96.

Antimony in 1922, by Edward Sampson. Pp. 107 to 112.

Fluorspar and Cryolite in 1922, by Hubert W. Davis. Pp. 15 to 22.

Salt, Bromine, and Calcium Chloride in 1922, by K. W. Cottrell. Pp. 23 to 29.

Asbestos in 1922, by Edward Sampson. Pp. 31 to 37.

Nitrates in 1922, by George Rogers Mansfield. Pp. 39 to 40.

Graphite in 1922, by Arthur H. Redfield. Pp. 63 to 68.

Boundaries, Areas, Geographic Centres and Altitudes of the United States and the Several States (with a brief record of important changes in their territory), by Edward M. Douglas. Pp. VI. + 234.

Triangulation and Primary Traverse, 1916-1918, by C. H. Birdseye. Pp. 914.

Rock Formations in the Colorado Plateau of South-eastern Utah and Northern Arizona, by C. R. Longwell, H. D. Miser, R. C. Moore, Kirk Bryan, and Sidney Paige. Pp. 23.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

28997—Chemische Fabrik Griesheim-Elektron.—Manufacture of acylacetyl compounds. Nov. 16.

Specifications Published this Week.

p-Nitrophenetol is prepared by heating an aqueous alcoholic solution of *p*-nitrochlorbenzene of low concentration with a quantity of an alkaline reagent, such as sodium ethoxide, not substantially in excess of that chemically equivalent to the chloro-derivative, at or above the normal boiling-point of the aqueous alcohol and without ebullition. For concentrations of the chloro-derivative of 3 per cent. and upwards, less than the equivalent of the alkali may be used. According to examples, concentrations of 3 and 5 per cent. of *p*-nitrochlorbenzene in 85 per cent. alcohol are heated with sodium ethoxide and caustic soda respectively in an autoclave and at temperatures of 90-120° C. To prevent reduction to azoxy-compounds the autoclave is lined with enamel, silver, or nickel.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d.

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THE CHEMICAL NEWS,

VOL. CXXVII. No. 3322.

ARE THE NATURAL GROUPINGS OF THE ELEMENTS AND THE SPECTRAL LINES OF HYDROGEN RELATED?

PART VI.

By F. H. LORING.

In continuation of the above study from *The Chemical News*, 1923, CXXVII., p. 355, the following observations will be given:—

NOTES AND COMMENTS.

1.—The advent of the octet theory of atomic structure and the palnetary theory of the atom as developed by Niels Bohr has placed before chemists a quantity of valuable theoretical matter which is difficult to harmonise; for, How can the electrons describe elliptical and circular orbits round atomic nuclei and at the same time function as practically stationary bodies disposed round each nucleus in various patterns as demanded by the followers of the octet theory?

It has been suggested in this paper that the Bohr orbits are in reality radiation orbits, and that the vibrations of the electrons are electro-mechanically equivalent to such orbits. It was shown that ponderable mass as such need not be a factor in the phenomena of orbital paths, since the orbits were not finally governed by the moving mass magnitudes; but, on the other hand, *velocity* is an important factor. In addition to this, the *entrant direction* of the moving entity should be taken into account. For example, a comet entering the solar system in a certain direction, *i.e.*, moving towards the immediate region of the sun, while then travelling with a certain velocity, will fall under the sun's influence and describe a certain orbit round it. At the most distant part of its orbit, that is to say, at its aphelion, the comet is moving at a momentary zero velocity relative to the sun, and it is then that it changes its direction and returns to the region of the sun, the orbit being elliptical; just as a ball thrown upwards *from the earth comes* instantaneously at rest relative to the earth at a certain height, and then falls back to the earth, describing an ellipse having no area—which is a straight line. Whether the ball be light or heavy, without air friction it could be made always to describe the same path or orbit of zero area, and its acceleration would be the same also. In this case the mass of the ball is not a factor in the time-rate-of-change of velocity.

The planets, that travel out orbits in accordance with the place law of Bode, vary irregularly in mass in respect to one another, so that no direct connection between mass and the particular orbit selected is possible. Again, the effect of mass is an antecedent one, and this is an important matter, for mass is functionally a prior condition in the phenomenon, which is related to the energy expended in producing the initial velocity, and of course the mapping of the subsequent velocities as well, for it determines the velocity at which a given body may enter a planetary system; or, in the instance of the ball, the height to which it is thrown by the thrower.

Now, if the orbits which the planets describe be regarded as definitely predetermined places in space, this "predetermination" must rest upon the antecedent factors just indicated, so that any orbit is possible, according to the entrant direction and velocity, which may be considered jointly; and this joint effect in turn rests upon the preceding event in which the energy (1) acting on the mass (2) were the predominating factors. The whole phenomenon dates back, as it were, to the initial energy and mass conditions, which have to be considered retrospectively with regard to the entrant direction and speed at a given place relative to the sun.

The orbit in the hydrogen atom must similarly depend upon the initial energy conditions if the phenomena discussed are of a parallel nature, as would seem to be the case. The formation of the planetary system then is akin to the condition of affairs that takes place in the spectrum processes of hydrogen: but, the question arises—How far back are the antecedent conditions to be carried?

Considering the atom, since there is only *one* electron belonging to hydrogen, the antecedent conditions do not in the several processes of radiation go back as they do in the planetary system, containing nine planets (counting the asteroids collectively *as one*). *Moreover, since the* hydrogen orbits are mathematically regular and always the same when they are rendered, so to speak, visible by the resulting emission lines, the energy conditions as regards direction and velocity is always the same

for each line. How, then, can this state of affairs be explained?

It seems that the electron can only take up energy in multiples of a given quantum, *and give out energy in the same multiples*, according as the electron is driven from one "orbital" place (radial place) to another, and this is quite in accord with Bohr's quantum-energy theory of the hydrogen atom. The electron can only take up and give out a quantum of energy which corresponds to its position relative to the nucleus, and therefore it must be under a constraining influence to do this; so that what corresponds *to the antecedent event in the case of the planetary system is practically concurrent* with the radiation phenomena of the atom.

This, then, involves the *energy* and *mass* of the electron, if the case is like that of the planetary system; but since the mass factor under consideration is not necessary to the orbit as such, it can be regarded as the determining factor in the *vibration* of the electron. In other words, in the case of the atom the antecedent factor is the vibration of the electron. The immediately subsequent *factor is the radiation which*, according to this view, describes practically closed orbits round the nucleus, and the final occurrence is the passage of this radiation out as a radial radiation when the electron is driven or falls towards the nucleus into another position of equilibrium in which it vibrates according to its place. The influence of the sun, or the atomic nucleus, is of course most important; but the observations are here concerned more *particularly with the behaviour of the orbits* in respect of their relative spacial positions.

2.—One difficulty that arose from the many-electron orbits of Bohr's theory was the complex magnetic phenomena which should theoretically arise from so many circulating negative electrons corresponding in effect to closed electric circuits. The hydrogen atom should then behave like such a circuit and exhibit magnetic effects, and many elements should show similar effects; *whreas, only a few elements give rise to* strong magnetic phenomena, these being iron, cobalt, nickel. Now, in the atoms of these three elements there may be electrons so situated that, under certain related conditions, they are free to describe orbits, but in practically all other elements the electrons can only vibrate, as according to this study such a conclusion seems inevitable.

3.—Referring to the wedge periodic table, attention should be drawn to a feature of some suggestive value; that is to say, the characterisation of the element by the width of the wedge where the element falls. In science, geometric *representation of a quantity* or quality, in which the origin of the plan is not known, is often more truly scientific because of its non-committal nature; for truth is often better expressed by a non-commital scheme than by one based upon highly artificial and ingenious hypotheses.

4.—In referring to the spectral lines of hydrogen, it should be noted that there are several types of spectra, namely: (1) the *Balmer series lines*; (2) the *many-lines spectrum, called the secondary spectrum* of hydrogen; (3) the Lyman series lines; (4) the Paschen series lines; (5) the Brackett series lines; (6) a continuous spectrum without lines; (7) a fine-line series due to the relativity effect in connection with each so-called single line. In the case of the Balmer series, it is frequently expressed mathe-mathematically in ν terms, as are also the others of like type, as follows:—

$$\nu = N \; \frac{1}{1^2} - \frac{1}{n^2} \quad \text{(Lyman.)}$$

$$\nu = N \; \frac{1}{2^2} - \frac{1}{n^2} \quad \text{(Balmer.)}$$

$$\nu = N \; \frac{1}{3^2} - \frac{1}{n^2} \quad \text{(Paschen.)}$$

$$\nu = N \; \frac{1}{4^2} - \frac{1}{n^2} \quad \text{(Brackett.)}$$

N = the Rydberg constant.

The *frequency* equals the velocity of light (c) in centimetres per second divided by wave length (λ), also in centimetre measure; but the Rydberg constant is usually evaluated by the equation in which ν = *wave number*, or $1/\lambda$ cm., so that

$$N = (4n^2/n^2-4) \times (1/\lambda \text{ cm}),$$

in which n for the Balmer series runs 3, 4, 5, 6, 7, &c.

5.—Referring to the planets and the group numbers, the average percentage of error, not counting the asteroids, is as follows:—(-0.29) + (-1.16) + (-0.33) = (-2.78). (-2.78/3) = (-0.926). (-0.926) - (+0.28) = (-0.646). 6.72 + 9.29 + 14.16 + 48.33 = 78.50. 78.50/0.646 = 121. 100/121 = 0.8 per cent. The respective summations are 77.0 and 78.50.

6.—Referring to Bode's law, it will be seen that it is not mathematically regular in respect of the first term; and that it de-

parts appreciably from the planetary values above 52.02. Similarly, the group rule indicated agrees with the planetary values just where Bode's law agrees, thus suggesting that the complete law of the planets is perhaps expressible by two formulæ.

7.—The coronium line, 5303, would by the formula given correspond to the upper limit of the asteroids, for it would give a value 28.7. The mean 28.7 + 21 = 24.8, which is close to the asteroid mean of 25. No importance whatever can be attached to this observation; but it is given to show that strange lines might be considered in connection with the relations given.

8.—Having accorded preference to Vegard's theory in respect of the constituent of the upper atmosphere, attention may be here drawn to another theory, equally valuable for the purpose of the main argument, due to H. Bongards (*Phys. Zeit.*, 1923, Vol. XXIV., p. 279). This paper is abstracted in *Science Abstracts* for November, 1923; and to give the readers of *The Chemical News* this information, the abstract is mainly reproduced here: "Slipher found for the wave-length of a green line discovered by Wiechert in the night sky of middle latitudes the wave-length 5578.05 A, while Vegard found $\lambda = 5578.2 \pm 1$ for what is generally regarded as the same line in the aurora. A faint line in the multiple line spectrum of hydrogen, $\lambda = 5578.3$, can hardly be identified with this; and the only other known line of the right wave-length is $\lambda = 5577.98$ in the blue spectrum of argon. There are many other lines in this spectrum and in that of the aurora; but so far the latter has not been measured with sufficient accuracy to allow of identification, as the number in both cases is so large at the violet end of the spectrum; but there is additional evidence in the fact that in the red portions of the aurora Vogel found two bright lines, $\lambda = 6297$ and $\lambda = 5189$; these measurements were taken in 1871, and are regarded as fairly accurate. In the red argon spectrum, which appears to be due to argon atoms which have lost one electron, Paschen found a bright line, $\lambda = 6297.15$, and Kayser another, $\lambda = 5188.46$; these are probably identical with the above auroral lines. In spite of its high density argon may be present normally in the atmosphere at heights above 100 km. where the aurora is seen; volcanic eruptions may carry this gas to great heights, and the thermodynamical properties of monatomic gases favour their remaining at high elevations when they have attained them; the author, however, favours the view that argon particles are ejected from the sun, with very high velocities, and entering the earth's atmosphere produce the aurora. There are difficulties in the way of this theory. The absence of Doppler effect indicates a velocity less than 3×10^7 cm., which would not enable the particles to penetrate so deep into the atmosphere; the argon particles may leave the sun strongly positively charged, with a very high velocity, and being devoid of the electrons which are concerned in radiation do not begin to emit light until, by collisions with the atoms of the air, they have lost much of their velocity, and picked up the necessary electrons. . . . ."

A Modified View of the Atom Arising Out of this Study.

9.—If the extended argument of this study is in general true in its purport, then it can be said that the natural groupings of the elements are linearly related to the wave-lengths of the first five Balmer lines of hydrogen; but still further evidence is needed before the argument as a whole can reasonably be considered sound. It was suggested that, in conformity with the findings of this study, the Bohr atom was really static as regards the electron movement other than vibration and radial displacement, and that the Lewis-Langmuir theory could stand on its own merits as a consequence.

Now it is not out of order to consider an atom-model along the lines suggested. In the first place it will be conducive to clearness to state the facts and concepts upon which such a model can be constructed. These are:—

(*a*) Rutherford's monumental work on the nucleus theory of the atom is based on such fine experiments and consistent reasoning that it is everywhere accepted as a fact. Stated otherwise, the atom has a nuclear part which is a positive charge corresponding in magnitude exactly with the atomic number, the latter having been experimentally established by the work of Moseley, which is well known.

(*b*) In view of this study it is suggested that the electron can vibrate to and fro relative to the positive nucleus in *all* positions, but only in those in which the radiation closes synchronously on the electron can it be held in a fixed place.

(*c*) Under these circumstances, when

the electron, as the operator, is forced by the nature of events out of the fixed place, the closed radiation passes out from the atom at the velocity of light as light or radiant energy.

In general, for a series of energetic vibrations, the spacing of the lines will be wide; but for a series of minor vibrations the spacings will be close, which follows partly from (*a*) and (*b*) above.

Certain antecedent factors may govern the "energetics" of the electron. (See note 1 above.)

The position of the electron relative to the nucleus is governed by its amplitude of vibration or *vice versa;* so that for high frequencies it is able to be nearer the nucleus than for low frequency vibrations.

The high frequency vibrations are emitted in more widely spaced quanta, in accordance with Planck's equation, than the lower frequency vibrations, being no doubt governed by the probability of the occurrence owing to the nature of the mechanism. It is as if the inner position is more difficult to attain to frequently, whereas the outer positions are more vulnerable, so to speak, and consequently the phenomenon occurs oftener.

Corrections.

Owing to illness when the proofs arrived, the writer was unable to make all the corrections and amendments necessary. The following may therefore be noted:—

On page 275, 25th line from top, insert "of molecular or" next to the words "atomic weight." On page 290, right-hand column, 14th line from bottom, "continued" should read "concluded." On page 337, 1st column, 2nd line of text, "272" should read "273." On same page, 2nd column, 14th line from top, "contradiction" should read "contradistinction." On page 338, right-hand column, 28th line from bottom, next to the word "will" insert: "consist of doublets, while, if the number is even the spectrum." On page 339, left-hand column, 8th line from top of paragraph beginning with "The," "each" should read "such."

INDIGOID DYESTUFFS.

PART II.

BY R. F. HUNTER, F.C.S.

(*Continued from Page 359.*)

We now have to study the indigo analogues, and we shall first deal with indigo analogues derived from two similar component nuclei, following, as before, the classification of Thorpe and Ingold.

The first dye to be considered as derived from indole, apart from indigo or 2:2′ bis indole indigo, which has already been dealt with, is indirubin, indigo-red, or 2:3 bis indol indigo. This was synthesised by Bayer by condensing indoxyl and isatin. This was modified by Forrer, who replaced indoxyl with indoxylic acid and obtained an 80 per cent. yield.

Wahl and Bagard's synthesis consists of condensing oxindole with isatin chloride.

Among the substitution products mention may be made of the following:—

5 Methyl indirubin;
7 Methyl indirubin;
5′ Methyl indirubin;
5′:7′ Dimethyl indirubin;
5′ Bromoindirubin;
5′:7′ Dibromo indirubin;
5:5′ Dimethyl indirubin;
6:6′ Dibromo indirubin;
6:5′:7′ Trichloro indirubin.

The next analogue is 3:3′ bis indol indigo or iso indigo, obtained by Laurent in 1841 by heating isatyde. As derivatives we have:—

5 Bromo isoindigo;
5:7 Dibromo iso indigo;
5 Nitro iso indigo; and as homologues:
5 Methyl iso indigo.

This brings us to the indigoid dyes from thionaphthen, the most important of which is thio indigo, or 2:2′ bis thionaphthen indigo,

$$C_6H_4 \left< \begin{matrix} CO \\ S \end{matrix} \right> C : C \left< \begin{matrix} CO \\ S \end{matrix} \right> C_6H_4$$

prepared in 1906 by Friedländer, by an application of the Badische modification of the Heumann synthesis, in which thio salicylic acid replaces anthranilic acid. The present synthesis consists of the conversion of phenyl thio glycollic acid into hydroxy thio naphthen, this to thio indigo white, and thence to thio indigo. Another method is to convert anthranilic acid into the diazonium salt, this to dithio salicylic acid, this to thio salicylic acid, this to o carboxy phenyl thio glycollic acid, thence to hydroxy thio naphthen carboxylic acid to hydroxy thio naphthen, and thence to thio indigo.

Another method is to convert aniline into o amino thio phenol, to o amino phenyl thio glycollic acid, to o cyano phenyl thiogly-

boxylic acid, and this to 3 hydroxy thio naphthen. Another method depends on the condensation between thiosalicylic acid and acetylene dichloride, the bis thiosalicylic derivative of ethylene formed on dehydration proceeds directly to thio indigo.

Hydroxy thio naphthen can be converted into thio indigo by other means than oxidation. Thus, when hydroxy thio naphthen is brominated there are formed m no bromo and dibromo compounds, both of which readily pass into thio indigo. These methods are, of course, of no commercial balue.

Thionaphthenquinone, the thio analogue of isatin, deserves mention. It can be prepared in a variety of ways. For instance, the dibromo derivative above can be directly hydrolysed, or it can be treated with aniline, the product being the anilide of thio naphthenquinone from which aniline residue is removed by acid hydrolysis.

Further, hydrothio naphthen with nitrous acid yields a nitroso compound which, on hydrolysis, yields thio naphthenquinone. Among the substitution products and homologues of thio indigo, we might mention:—

7:7′ Dimethyl thio indigo;
4:6:4:6′ Tetramethyl thio indgo;
5:7:5′:7′ Tetramethyl thio indigo;
Bis 1:2 naphtha thiophen indigo;
Bis 1:8 naphtha thiophen indigo;
Bis 2:3 naphtha thiophen indigo;
Bis 2:1 naphtha thiophen indigo;
5:5′ Dichloro thio indigo;
5:5′ Dichloro 6:6′ dimethyl thio indigo;
7:7′ Diamino thio indigo;
6:6 Dichloro thio indigo;
6:6′ Diethoxy thio indigo;
5:6′ Dibromothio indigo;
4:4′ Dimethyl 6:6′ dibromo thio indigo;
6:6′ Dimethyl thio indigo;
5:5′ Dichloro 6:6′ diethoxy thio indigo.

2:3′ Bis thio naphthen indigo, or thioindirubin, is worthy of note, and has been prepared from hydroxy thio naphthen and thionaphthenquinone.

The indigoid dyes from coumarone are of interest:—

2:2′ Bis coumarone indigo, unlike its sulphur and nitrogen analogues, is not of technical importance. It has been prepared by condensation of coumaranone with p nitroso dimethylaniline, followed by hydrolysis with HCl to gem dimethyl p phenylenediamine and oxindigo.

2:3′ Bis coumarone indigo, or oxindirubin, has not been prepared, but methyl derivatives are known. We might mention:

5:5′ Dimethyl oxindirubin;
6:6′ Dimethyl oxindirubin;
5:6′ Dimethyl oxindirubin;
6:5′ Dimethyl oxindirubin.

Symmetrical indigoid dyes derived from other component nuclei are known. We might mention:—

2:2′ Bis indenone indigo;
1:1′ Bis acenaphthene indiyo;
3:3′ Dimethyl 5:5′ dimethoxy 1:1′ bis benzene indigo;
1:1 Bis phenanthrene indigo;
4:4′ Diphenyl bis 2:2 furan indigo;
5:5′ Diphenyl 2:2′ dimethyl 3:3′ bis pyrazole indigo;
3:3′ Bis isn carbostyril indigo.

This brings us to the indigo analogues derived from two dissimilar nuclei, of which ceba violet A, or 2 indole 2 thio naphthen indigo, is an example

The first class of these dyes are those formed by the union of any two or three component nuclei; indole, thio naphthen, and coumarone, following the classification of Thorpe and Ingold. As dyes from indole and thionaphthen, we have 2 indol 2 thio naphthen indigo, or ciba violet A, derivatives of this being 2(5 Bromoindole) 2 thio naphthen indigo 2(5:7 dibromoindole) 2 thio naphthen indigo 3 indol 2 thio naphthen indigo, or thioindigo scarlet R, from which derivatives have been obtained.

As dyes from indole and coumarone, we have 2 indol 2 coumarone indigo and 3 indole 2 coumarone indigo.

The sole dye from thionaphthen and coumarone is 2 thionaphthen 3 coumarone indigo.

The second class of dyes are formed by the union of either of the component nuclei; indole and thionaphthen, with a six membered homocyclic ring of the benzene type. We consider firstly, the dyes derived from indole by union with six membered homocyclic rings. We have:—

2 Indole benzene indigo; this indigo has not, as yet, been prepared, but derivatives of it are known. Derivatives with hydroxyl groups in the benzenoid component nucleus have been prepared by Friedlander by condensing the appropriate polyhydric phenols with isatin chloride. We might mention the dyes from resorcinol, catechol and pyrogallol. An amino derivative has been prepared by condensing isatin chloride with m hydroxy diphenylamine.

2 Indole 2 napthtalene indigo was prepared by Friedlander by condensing a naphthol with isatin chloride in benzene solu-

tion. Derivatives have been prepared from substituted α naphthols. We might mention the dyes obtained from monomethyl 1:4 dihydroxy naphthalene from 1:5 dihydroxy naphthalene and 5 acetamino 1 hydroxy naphthalene. Derivatives containing substituents in the indole nucleus have been obtained by condensing substituted isatin with naphthol.

Derivatives have been made by using azo dyes from diazotised base by coupling with α naphthol in conjunction with isatin α anilide.

2 Indole 1 naphthalene indigo has been prepared by Friedlander from isatin chloride and naphthol.

2 Indole 2 anthracene indigo has been prepared by the same author from isatin α anilide and α anthrol. Derivatives are known.

Hydroxyl derivatives have been prepared by condensation of 1:5 and 1:8 dihydroxy anthracene with isatin α anilide. Some important dyes have been prepared by condensing 5 chloro, 5 bromo, 5:7 dichloro, 5:7 dibromo isatins with anthrol and 1:5 and 1:8 dihydroxy anthracene. Similar compounds have been prepared by condensing 7 methyl isatin chloride, 5:7 dimethyl isatin chloride, and 5:6 methylene dioxy isatin chloride with α anthrol and 1:5 and 1:8 dihydroxy anthracene. Blue dyes have been prepared by condensing hydroxy anthrone with isatin chloride and 5:7 dibromo isatin chloride.

2 Indole 1 anthracene indigo has been prepared by Bezdrik from β anthrol, just as 2 indole 2 anthracene indigo is prepared from α anthrol.

2 Indole 3 acenaphthene indigo has been obtained from isatin α anilide and 4 hydroxy acenaphthene. by replacing 5:7 dibromo isatin chloride in place of the anilide 2 (5:7 dibromoindole) 3 acenaphthene indigo is obtained.

As dyes derived from thio naphthen by union with six membered homocyclic rings, we have:—

2 Thionaphthen 2 naphthalene indigo from α anilide of thio naphthen quinone and α naphthol;

2 Thionaphthen 2 anthracene indigo from α anthrol and α anilide of thio naphthen quinone;

Thionaphthen 2 naphthapheno carbazole indigo and 2 thio naphthen 2 naphtha azole indigo.

We now h‸us to the third class of dyes, logues, and we ‸ the union of either of the component nuclei, indole and thionaphthen, with a five membered homocyclic ring of the type contained in indene. We consider first the dyes from indole and 5 carbon rings. An example of these is 2 indole 2 indene indigo, prepared by Friedlander, by condensing isatin chloride with α hydrindone.

2 Indole 1 indene indigo has been prepared from hydrindone and isatin α anilide in the presence of pyridine.

2 Indole 1 acenaphthylene indigo has been prepared from indoxyl and acenaphthenquinone, and also by condensation of acenaphthone and isatin chloride.

Halogen derivatives have been prepared by using dibromo diacetyl indoxyl in the place of indoxyl or dibromoisatin in place of isatin and by direct halogenation of the parent dye.

The dyes from thionaphthen and five carbon rings are of interest.

2 Thionaphthen 1 indene indigo has been prepared by treating hydrindone with acetic anhydride and with the condensation product of p nitrosodimethylaniline and 3 hydroxy thionaphthen. 2 thionaphthen 2 acenaphthylene indigo, better known as ciba scarlet, has been prepared by condensing 3 hydroxy thionaphthen with acenaphthaquinone in an acetic acid solution in the presence of hydrochloric acid in small quantity as condensing agent. It has also been prepared by heating acenaphthaquinone with 3 hydroxy thio naphthen 3 carboxylic acid. Halogen derivatives of ciba scarlet are known.

2 Thionaphthen 1 aceanthrylene indigo has been prepared from 3 hydroxy thionaphthen and aceanthraquinone.

The fourth class of dyes are those formed by union of the component nucleus indole with six membered heterocyclic rings, of which 2 indole 3 isocarbostyril indigo is an example.

We conclude with the fifth class of dyes, those formed by union of either of the component nuclei, indole and thionaphthen, with five membered heterocyclic rings. 2 indole dihydroxy pyrimidine indigo is an example of a dye containing a simple six membered heterocyclic ring as one of its compound nuclei, and is prepared by condensation of isatin α anilide with barbituric acid in the presence of acetic anhydride.

2 Indole 4 pyrazole indigo is the parent of a class of dyes of which only two are known at present. The 3′ methyl and 1′ phenyl 3′ methyl derivatives have been obtained by

condensation of isatin anilide with 3 methyl and 1·phenyl 3 methyl pyrazolone.

2 Indole 2 isoxazole indigo has been prepared by condensing isatin chloride with the corresponding aromatic isoxazolone.

2 Indole 5 thia zolthiole indigo has been prepared by condensing isatin anilide and rhodaninic acid in the presence of acetic anhydride.

2 Thionaphthen 5 thiazol thiole indigo, the last dye we shall consider, has been obtained from the α anilide of thio naphthenquinone and rhodaninic acid.

The Royal College of Science,
October, 1923.

GENERAL NOTES.

A report on the present position of the stocks of drugs and chemicals, etc., in Japan has been received from the Acting British Consul at Osaka, copies of which, together with lists of importers in Japan, may be obtained by British firms upon application to the Department of Overseas Trade.

ATMOSPHERIC CORROSION.

The First Experimental Report to the Atmospheric Corrosion Committee of the British Non-Ferrous Metals Research Association will be presented and discussed at a meeting of the Faraday Society, to be held on December 17, at 8 p.m., in the rooms of the Chemical Society, Burlington House, W.1. The very comprehensive series of field tests and laboratory experiments described in the Report were carried out by Mr. W. H. J. Vernon on behalf of the Committee. Persons interested in the subject desirous of attending the discussion may obtain a ticket of admission from the Secretary of the Faraday Society, 10, Essex St., London, W.C.2.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

THURSDAY, DECEMBER 6.

Papers read :—

E. G. T. LIDDELL and SIR CHARLES SHERRINGTON, PRES. R.S., *Recruitment Type of Reflexes.*

G. S. CARTER, *The Structure and Movements of the Latero-Frontal Cilia of the Gills of Mytilus.* Communicated by Prof. J. S. Gardiner, F.R.S.

Papers read in title only :—

V. B. WIGGLESWORTH and C. E. WOODROW, *The Relation between the Phosphate in Blood and Urine.* Communicated by Prof. F. G. Hopkins, F.R.S.

It has been shown that ingestion by man of doses of the acid and alkaline sodium phosphates containing 1½-2 grammes of phosphorus causes a rapid 50-60 per cent. increase in the blood phosphate, which then returns very gradually to the normal level. The work of others has shown that phosphate is so rapidly excreted by the kidneys of the dog that no such increase occurs in that animal under similar conditions.

In such experiments the curve of urinary excretion of phosphate runs roughly parallel to that of the blood concentration, but the former varies much more widely than the latter, and is roughly proportional to the excess above a certain value in the blood. Moreover, the rate of excretion in the urine is independent of the amount of water excreted.

In a study of the partition of the inorganic phosphate between the plasma and corpuscles of the blood, it has been shown that under conditions in which the blood phosphate is subnormal, normal, or slightly above normal in amount, the concentrations in plasma and corpuscles are identical. When the concentration in the plasma rises far above normal the value for the corpuscles is always lower, whether the plasma value is rising or falling. This unequal partition is not to be explained by the formation of an organic "acid-soluble" phosphorus compound in the corpuscles, for the organic fraction of the acid-soluble phosphorus is not increased by the ingestion of phosphate; nor is this fraction increased by taking glucose or a mixture of glucose and phosphate, as might have been expected if one of its constituents were a hexosephosphoric ester.

J. B. S. HALDANE, V. B. WIGGLESWORTH and C. E. WOODROW, *The Effect of Reaction Changes on Human Inorganic Metabolism.* Communicated by Prof. F. G. Hopkins, F.R.S.

Over-breathing diminishes the phosphates in blood and urine, while carbon dioxide inhalation and sleep increase them.

In acidosis caused by ammonium-chloride ingestion the urinary phosphate is increased; while the phosphate of the blood, and also its organic acid-soluble phosphorus, is diminished. Ammonium-chloride acidosis leads to an increased excretion of water, sodium, and potassium, probably owing to a partial loss of electric charge by the body colloids. This is followed by a retention.

J. B. S. Haldane, V. B. Wigglesworth and C. E. Woodrow, *The Effect of Reaction Changes on Human Carbohydrate and Oxygen Metabolism.* Communicated by Prof. F. G. Hopkins, F.R.S.

The alkalosis of over-breathing or bicarbonate ingestion converts the blood sugar into a highly dextrorotatory, unoxidisable form, and also prevents glucose storage: thus causing acetonuria and lowered respiratory quotients and glucose tolerance. Ammonium-chloride acidosis interferes with the storage of glucose, but not with its oxidation. Bicarbonate ingestion raises the resting oxygen consumption; ammonium-chloride ingestion usually lowers it.

J. A. Campbell, *Concerning the Influence of Atmospheric Conditions upon the Pulse Rate and "Oxygen-Debt" after Running.* Communicated by Prof. L. Hill, F.R.S.

The "oxygen-debt" for 25 minutes after ceasing to run showed, under fixed conditions of experiment, a range of variation of 38 per cent. from day to day; 7-minute debts showed a range of 33 per cent., so should do as well for comparative purposes as 25-minute debts. Atmospheric cooling power had no effect on the "oxygen-debt"; the blood sent in greater volume through the skin in warm conditions is not then taken from the muscles. "Stitch" was the commonest cause of cessation of running in the subjects—not first-class athletes—under observation. Pulse rate is markedly increased under warm conditions. This is not always shown clearly in short experiments in cool conditions, because it takes time for the body mass to become heated up. The oxygen tension surrounding the muscles was increased after exercise.

J. Gray, *The Mechanism of Ciliary Movement. IV.—The Relation of Ciliary Activity to Oxygen Consumption.* Communicated by Prof. J. S. Gardiner, F.R.S.

We the absence of atmospheric oxygen gues, activity continues for about one hour. From a study of the effect of various reagents upon the mechanical activity and on the oxygen consumption of ciliated cells, it is concluded that the whole ciliary mechanis mis divisible into three distinct parts: *(i) a reaction which is sensitive to* cations (particularly the hydrogen-ion), any interference with which involves a change in the rate of the ciliary beat, but only ultimately leads to a change in the amount of *oxygen consumed; (ii) a mechanism which* appears to be brought into operation by the presence of an activating acid substance. This mechanism is inoperative in the absence of calcium, and in the absence of a certain critical amount of water in the cell. The events associated with this mechanism are independent of and have no influence upon the amount of oxygen absorbed; (iii) a reaction of an oxidative nature which is necessary for prolonged activity.

As far as they are at present known, the properties of the ciliary mechanism form a very close parallel to those of cardiac muscle, as illustrated by the sinus region of the heart.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

An Ordinary Meeting was held on Thursday, December 13. A paper entitled *Pulverised Fuel and Efficient Steam Generation*, was read by D. Brownlie.

Pulverised Fuel and Efficient Steam Generation—A Detailed Consideration of the Performance of Pulverised Fuel as compared with Mechanical Stoking under the most Modern Conditions, by David Brownlie, B.Sc.

The paper is a detailed consideration of the latest developments in the use of pulverised coal for steam generation, and a comparison of the advantages and disadvantages of this method of firing as compared with mechanical stoking, in each case under the latest improved conditions and more particularly as applied to very large power station boiler plants. Since the starting up in December, 1920, of the pioneer large installation, Lakeside, Milwaukee (40,000 k.w. on "Lopulco" pulverised fuel), the progress made in the United States has been remarkable, and 3,500,000 tons of pulverised coal will shortly be burnt per annum under water-tube boilers.

The paper contained a full account of the

Lakeside station, particularly the exact working costs, whilst a description was also given of the River Rouge plant at Dearborn, Detroit, as representatives of the latest pulverised-fuel practice. For comparison, a similar account is given of the Dalmarnock power station, Glasgow, characteristic of the best British mechanical stoker practice.

The author is of the opinion that the advantages in the aggregate of pulverised fuel are so remarkable that they constitute almost a revolution in steam boiler practice. The paper also contained a large amount of general statistical matter.

A Wireless Section Meeting was held on Wednesday, December 5. A paper entitled *The Relation between Damping and Speed in Wireless Reception* was read by L. B. TURNER, M.A. (Member).

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The Seventy-Fourth General Meeting was held on Tuesday, December 11, when the following paper was read:—

The Modern Rotary Drilling System, by L. R. MCCOLLUM.

The chair was taken by the President, H. Barringer, M.Inst.C.E., M.I.Mech.E., M.I.N.A., M.Inst.Mar.Eng.

PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF LONDON.

NOVEMBER 21.

Prof. A. C. Seward, Sc.D., F.R.S., President, in the chair.

The following communication was read and discussed:—

The Development of the Severn Valley in the Neighbourhood of Iron-Bridge and Bridgnorth, by LEONARD JOHNSTON WILLS, M.A., PH.D., F.G.S.; with a Section on the Upper Worfe Valley, in collaboration with Ernest Edward Leslie Dixon, B.Sc., F.G.S.

A meeting of the Society was held on Wednesday, December 5, when the following communications were read:—

The Geology of Southern Guernsey, by D. J. FARQUHARSON, M.Sc. Communicated by Prof. O. T. Jones, D.Sc., M.A., F.G.S.

The Geology of the Northern Border of Dartmoor between Whiddon Down and Butterdon Down, by C. W. OSMAN, M.INST.C.E., F.G.S.

Specimens and lantern-slides of Arachnid remains from the Rhynie Chert were exhibited by Dr. F. A. Bather, M.A., F.R.S., on behalf of Mr. A. S. Hirst, F.Z.S.

THE SOCIETY OF GLASS TECHNOLOGY.

A meeting was held in Leeds on November 21, the President, Prof. W. E. S. Turner, D.Sc., in the chair. Three papers were presented.

Notes on the Influence of Rapid Chilling on the Reversible Expansion of Clay, by H. S. HOULDSWORTH, M.Sc.

The author gave results of measuring the reversible thermal expansion of fireclay test pieces cooled slowly and rapidly. Test pieces were moulded from Farnley fireclay, dried and fired in the surface combustion laboratory furnace to Cone 9 (1280° C.) in three hours and maintained at that temperature for two hours more. One piece was removed from the furnace and plunged into cold water, and another was placed on a steel plate to air cool, while a third was slowly cooled in the furnace. A glass pot mixture of clay and grog obtained from Stourbridge in a leathery condition was next examined. There was a considerably greater difference in the temperature-expansion curves of the rapidly chilled and slowly cooled specimens after firing at Cone 9 than was found for Farnley fireclay. The expansion of the air-cooled test pieces was intermediate between those of the water-cooled and slowly-cooled samples. At Cone 14 (1410°) the thermal expansion of the air-cooled and water-cooled specimens were nearly the same and considerably less than that of the slowly cooled test pieces.

The whole of the phenomena were consistent with the explanation that solution of free silica occurred at higher temperatures, and separated out as cristobalite or tridymite on slow cooling, exerting its characteristic influence on the expansion curve, but that it did not so separate on rapid cooling. Some imperfect separation was possible.

Glasshouse Pots—Some Notes on their Manufacture and Use, by MR. PERCIVAL MARSON (read by Prof. W. E. S. Turner).

After suitable weathering the fireclays used as pot clays were ready for blending, mixing, and grinding. Part of the new

mined lumps of fireclay were selected and sent to the kilns for burning. When burnt, these were broken up and ground down for the grog used in the pot clay mixtures. It should not be burnt to less than 1350° C., and should be free from the faults of burning, such as black core and soft firing. The grinding and grading should also be kept within prescribed standards.

The methods of pot manufacture were noted, the author observing that pots which had been stored for two or three years, after drying, gave more regular and reliable results than new pots used shortly after drying. Reference was made to the different practices in vogue in heating up pots in the pot arch. Mention was also made of the chief faults which pots developed in the drying room, pot arch and furnace.

The Casting Process for Glasshouse Refractories in German Glass Plants, by PROF. KURD ENDELL, DR.PHIL. OF THE TECHNISCHE HOCHSCHULE, Charlottenburg, Berlin.

Prof. Endell considered that the casting process would give satisfactory results in practice. He was unable to present any precise experimental results on chemical resistance to molten glass, but he believed that cast pots were chemically more resistant than hand-made pots.

THE ROYAL INSITUTION OF GREAT BRITAIN.

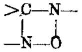
A General Meeting of the members of the Royal Institution was held on December 3, Sir James Crichton-Browne, Treasurer and Vice-President, in the chair. It was announced that the Managers had elected Mr. Joseph Barcroft. F.R.S., Fullerian rofessor of Physiology, in succession to Sir Arthur Keith. The special thanks of the members were returned to Dr. Rushton Parker for his donation of one hundred pounds towards the improvement of the Library. M. le Duc de Broglie, Dr. C. L. Guillaume and Professors Debye, Einstein, Groth and von Laue were elected honorary members of the Institution. Miss Day, Mrs. Grimsdale, Mrs. King, Miss Moller, Mrs. Tippinge, Sir George Beilby, Colonel Hippisley, Sir Alfred Hopkinson, Sir Richard Paget, Dr. J. H. Jeans, F.R.S., Professor Arthur Smithells, F.R.S., and Messrs. A. S. C. Ackermann, F. H. Hargrove, H. M. Hubbard, F. L. Lawson-Johnston, M. Mannaberg, E. B. Michell, A. Muller, B. J. Orsman, and G. Shearer were elected members.

THE CHEMICAL SOCIETY.

Papers read at the Ordinary Meeting, December 6:—

The additive formation of four-membered rings. Part III. A system of Nomenclature for Heterocyclic our-membered Rings, and the formation and properties of some Derivatives of -methylene di-imine-oxide, by C. K. INGOLD.

Four-membered ring formation by the additive union of double bonds is found to be general. The variety of new heterocyclic ring-types produced from the five types of double bond studied (C:C, C:N, C:O, N:N, N:O), is such as to call or a definite scheme of nomenclature. One object of these investigations was to discover which types of four-membered heterocyclic ring were the most ctable. It has been shown that certain azomethines tend to pass into stable ring bimerides. There is also evidence that many nitroso-compounds pass into stable ring bimerides. Hence, if an azomethine and a nitroso-compound of the types referred to be placed together, they should unite, giving a ring in which 2 N-atoms are united to a C- and an O-atom. Experiment shows that the ring obtained in this way has the structure



It is quite stable at ordinary temperatures. Its constitution has been established by alternative synthesis, and by a study of its decomposition at a higher temperature.

The Dependence of Polarisation-overvoltage on Hydroxyl and Hydrogen Ion Concentration. Part I. Polarisation-overvoltage of an Antimony Cathode in Aqueous Alkaline Solution, by H. J. S. SAND and E. J. WEEKS.

The overvoltage, ω, of an antimony cathode in alkaline solution is found to obey the empirical equation: $\omega = a - 2h$ (h is the potential difference between a standard electrode and a hydrogen electrode in the solution examined, and a is a constant depending only on temperature). This result, as well as the spontaneous formation of gas-bubbles, may be explained by the assumption that an ion $H(OH)_2''$ exists which has a definite supersolubility limit. When a sufficient number of these ions have assembled to produce the energy necessary for the formation of a gas-bubble, they decompose simultaneously (explode).

Stereoisomerism and Local Anæsthetic Action in the β-eucaine Group. Resolution of β- and iso-β-eucaine, by HAROLD KING.

α- and β-vinyldiacetonalkamines on benzoylation yield O-benzoyl derivatives. Benzoyl α-vinyldiacetonalkamine is the local anæsthetic β-eucaine, and it is proposed to call benzoyl β-vinyldiacetonalkamine, iso-β-eucaine. The two were resolved by camphorsulphonic and bromocamphorsulphonic acid respectively. The resolution of β-eucaine was effected within the transition interval where the partial racemate dl-β-eucaine d-camphorsulphonate is the most stable form, whilst in the case of iso-β-eucaine, the salts being of approximate equal solubility, separate alternately from the solution on fractional crystallisation.

β-Alizarin. An Isomeric Form of Alizarin, by ALBERT GREEN.

When alizarin is boiled with thionyl chloride to complete solution, and the solvent is evaporated, a light brown solid is formed. Recrystallisation from glacial acetic acid and then from benzene or alcohol yields yellow needles, m.p. 195-7°. The light brown solid fumes in air, owing to decomposition of adhering thionyl chloride, and yields alizarin.

Analyses and molecular weight determinations of the yellow substance indicate the formula $C_{14}H_8O_4$. β-Alizarin is converted into alizarin by boiling with alcoholic solutions of hydrogen chloride, hydrogen bromide, or hydroxylamine hydrochloride. The same result is obtained by pouring its solution in concentrated H_2SO_4 into water or ether, or by acidifying its solution in aqueous sodium hydroxide. Bromination gives 3.bromo-1.2.-dihydroxy anthraquinone. Boiling for six hours with acetic anhydride β-alizarin gave pure diacetyl alizarin. Alizarin gave an impure product after 16 hours' boiling. Since 1.hydroxy anthraquinones are alkylated only with difficulty, while the ethers of 2.hydroxyanthraquinones are easily prepared, the former may have an o-quinonoid structure.

The Isomerism of the Oximes. Part XV. The supposed Fourth Benzildioxime, by O. L. BRADY and F. P. DUNN.

The authors have failed to obtain any evidence of the existence of a fourth benzildioxime.

The Alternation in the Heats of Crystallisation of the Normal Monobasic Fatty Acids, by W. E. GARNER and F. C. RANDALL.

The following values for the heats of crystallisation for fatty acids have been obtained:—lauric, 43.73; undecoic, 32.20; capric, 38.86; nonoic, 30.54; caprylic, 35.44 cal/gm. The heat of crystallisation of an odd acid is lower than the mean for its neighbours in the series, and the heat of crystallisation curve resembles the melting point curve for these acids. These results throw light on the causes of alternation in the physical properties of organic substances with long chains.

The odd acids, undecoic and nonoic, crystallise in two enantiotropic forms, α and β, and the heat of transition of these have been found to be 9.89 and 8.39 cal/gm. The heat of crystallisation of the β-forms of the odd acids lie slightly above the curve for the even acids, thus giving an example of inverse alternation. The results are in agreement with the view that the even acids are more closely related to the β than to the α forms of the odd acids. The differences between the heats of crystallisation of the higher members of the odd and even acids may be ascribed to differences in the mode of attachment of the carboxyl groups in the crystal molecule.

ORDINARY SCIENTIFIC MEETING, THURSDAY, DECEMBER 20, 1923, AT 8 P.M.

The following papers will be read:—

The Relation between the Glow of Phosphorus and the Formation of Ozone, by W. E. DOWNEY.

The Origin of Mutarotation and the Mechanism of Isomeric Change. A Reply to Baker, Ingold and Thorpe, by T. M. LOWRY.

The Action of Inorganic Haloids on Organo-Metallic Compounds, by F. CHALLENGER and F. PRITCHARD.

Organo-Derivatives of Bismuth. Part VII. Iodo- and Nitro-Derivatives of Triphenylbismuthine, by J. F. WILKINSON and F. CHALLENGER.

THE FARADAY SOCIETY.

GENERAL DISCUSSION ON "ELECTRODE REACTIONS AND EQUILIBRIA," NOVEMBER 26.

(*Continued from Page 365.*)

The Gas Film Theory of Overvoltage, by N. V. S. KNIBBS.

The theory which attributes overvoltage to a film of gas on the electrode affords an-

other instance of a discredited theory which is essentially correct.

Suppose a metal, the surface of which is free from adsorbed gas, to be made cathode in dilute sulphuric acid, any suitable anode being used. It is known that even with a very low cathodic potential a considerable current passes for a very short time, followed by a slight "residual" current. This pulse presumably occurs because the electrode is free from electromotively active hydrogen. Once current has passed the electrode becomes, in effect, a hydrogen electrode, and only the residual current (replenishing the hydrogen which diffuses away) passes until the cathodic potential exceeds that of the hydrogen electrode. A point that it is here desired to make is that the hydrogen in some way must cover the metal surface, and it seems natural to conclude that it is adsorbed to the surface. Now, suppose the potential to be increased until visible gas formation begins. What is the mechanism by which the ions are discharged and evolved as gas bubbles?

Rideal maintains that the hydrogen ions must be adsorbed to the electrode in order that they may be discharged. The discharged ions (atoms) then unite to form molecules which are still adsorbed but which evaporate at a definite rate into the electrolyte or into any neighbouring gas bubble. Except at platinised platinum and similar surfaces this rate is equivalent to only a minute current density and therefore at any ordinary current density the ions must perform the work of describing the hydrogen molecules before they can discharge. The energy of desorption is held to be equivalent to the overvoltage.

Some investigators maintain that the discharged ions form molecules which pass into solution in the electrolyte forming supersaturated solutions. Others assume that the monatomic hydrogen formed by the discharge of the ions accumulates on the electrode owing to the finite velocity of the reaction: $2H_1 = H_2$. Another suggestion is that a compound of the metal with hydrogen is formed either as an intermediate compound or as a side reaction.

Regarding the supersaturated solution theory the question arises as to why such a solution (which must be of high supersaturation to explain even the lowest overvoltages) is formed when the hydrogen molecules could attach themselves to the electrode or pass into the gas phase immediately. No adequate reasons have been given. The monatomic hydrogen thory postulates that the magnitude of the overvoltage depends on the concentration of monatomic hydrogen, but the latter will vary with the current density in a manner easily calculable and the actual variation differs from that calculated. The metal hydride theory has the disadvantage that no such compounds are known, and there seems no reason why they should form.

There can be little doubt that the hydrogen atoms or molecules will be adsorbed to the surface, but once all spaces are occupied the nature of the process becomes more open to conjecture. It is not easy to picture the process of the ion ejecting the molecule from the surface, as postulated by Rideal. One rather pictures the ions crowding on top of the molecules and tending to inhibit desorption.

No mention has yet been made of anodic overvoltages, and until further measurements have been made speculation is not very profitable. Even the recent measurements of Knobel, Caplan, and Eiseman are not of much assistance. Halogen overvoltages seem to increase almost proportionally to the current, and except on graphite do not reach high values at the current densities at which measurements have been made. It is unlikely that the conditions which obtain with gases of low solubility such as hydrogen and oxygen are reached at any reasonable current density with such a highly reactive and soluble gas as chlorine. All investigators agree that oxygen overvoltages are much more variable than those of hydrogen and reproducible results are difficult to obtain. This may be due to the formation of actual oxide films, not always visible, on the anodes. In general, oxygen overvoltages seem to be higher than the hydrogen overvoltages at the same metals, due, perhaps, to the greater affinity of the metals for the former gas.

The Influence of Obstructive Films on Anodic Processes, by Ulick R. Evans.

The anodic attack of a metal proceeds readily when the product is *soluble*, or even when it is *insoluble but non-adherent;* but an *adherent insoluble* film may interfere with further attack of the anode, and may even (if non-conducting) produce valve-action. The degree of adhesion of the film depends partly on considerations of interfacial energy; but the substance is more likely to be adherent if it is the *direct product of anodic attack*, than if it is produced

by precipitation at a small distance from the anode surface. *Passivity* is probably due to a layer of attached oxygen atoms (or half-discharged oxygen-rich ions); it may be regarded as an oxide-film, but is not identical with any oxide known in the massive state. Any treatment which tends to scrape off, reduce, dissolve or loosen this oxide tends to remove passivity. The oxygen atoms do not merely offer mechanical obstruction to electrodic dissolution, but causes a permanent or temporary shift in the potential at which equilibrium between the metal and its ions is established after current has ceased to flow; this is best explained by supposing that the attachment of oxygen atoms reduces the "active mass" of the metal, whilst leaving that of the ions unchanged. "Degrees of passivity" are possible, and one often meets with metallic specimens which are "*partially passive.*"

Most metals of the "A" groups of the Periodic Table appear to be *permanently passive;* although these elements cannot—in general—be obtained by electrodeposition from aqueous solution, the metals have a simulated nobility, due to an adherent oxide-film (tantalum, tungsten, etc.); past experiments which claim to determine the reversible "electrode potentials" of such metals require—in some cases—a different interpretation. Likewise in the transition elements (iron, nickel, platinum, etc.). there seems to be a gap between the deposition-potential and the dissolution-potential, and this causes many apparent anomalies. Disagreement even still prevails as to whether iron should stand above or below cadmium in the Potential Series.

Studies in Heterogeneous Equilibria. Part II.—*The Kinetic Interpretation of the Nernst Theory of Electromotive Force*, by J. A. V. BUTLER, M.Sc.

The Nernst theory of the electrolytic P.D. of metals is developed on kinetic grounds, and a kinetic deduction of the Nernst equation is given. Values of the electrode potentials calculated in accordance with the equations are at least of the right order of magnitude. The Nernst conception therefore gives an adequate and physically acceptable explanation of the facts.

Studies in Heterogeneous Equilibria. Part III.—*A Kinetic Theory of Reversible Oxidation Potentials at Inert Electrodes*, by J. A. V. BUTLER, M.Sc.

When an inert electrode is dipped into a solution containing two substances related by a simple oxidation-reduction process, it usually acquires a perfectly definite and reversible electrode potential. Thermodynamically the electrical work done against this potential difference in the oxidation of one equivalent of the reduced substance at the electrode is a measure of the free energy of the process. Kinetically it may be supposed that the potential has its origin in the tendency of the more highly oxidised substance to take up electrons and that of the less highly oxidised substance to lose electrons, a transfer that occurs through the agency of the inert electrode.

It is pointed out that a metal which ionizes in two stages will contain in the solid form atoms that have lost electrons corresponding to both states. There will be a definite equilibrium between the two kinds of ions and electrons. The three processes occurring at the surface can only give rise to the same P.D. if the relative proportions of ions in the adsorbed layer are the same as in the interior of the metal. The solution which is in equilibrium with the metal is that which gives an adsorbed layer of ions in this proportion. The adsorbed layer is now identical in composition with the interior and there is no P.D. (E_s) between the two. That is, the whole P.D. is between the adsorbed layer and the solution, and this is now the electrode potential for all three processes concerned.

A general expression was deduced, which is in accordance with the thermodynamic equation and which distinguishes the factors determining the normal potential. The relation between the (Nernst) metal potential and the oxidation potential for a metal in a solution containing its ions in different stages of oxidation, was discussed.

Irreversible Electrode Phenomena, by H. J. T. ELLINGHAM and A. J. ALLMAND.

The occurrence of any process with finite velocity necessarily involves more or less irreversibility. In the case of an electrochemical reaction proceeding at given finite current density, the extent of the irreversibility under given conditions is indicated by the deviation of the potential of the electrode at which it is occurring from the corresponding equilibrium potential of the reaction. Thus the degree of irreversibility of an electrochemical reaction under various conditions may be conveniently summarised by curves showing the relation between the potential of the electrode and such variables as current density, time, temperature, etc.

The polarisation due to concentration

changes in the surface layers of the electrode generally cannot be estimated. It may vary from zero in a case where the electrode neither furnishes reactants the removal of which can change its composition, nor dissolves resultants of the reaction to any appreciable extent; to values which may be very large owing to slow rates of diffusion or low velocity of chemical reactions in solid solutions. The magnitude of the polarisation due to concentration changes in the boundary layer of the electrolyte, can, however, generally be computed approximately from the known diffusion coefficients of substances in solution and an estimated value of the thickness of the layer in which the concentration gradient is established. Polarisation of this kind which is usually known simply as "concentration polarisation" is generally small owing to the relatively high rates of diffusion of substances in solution and the relatively high velocities of chemical reactions under these conditions. Also conviction and ionic migration may assist in keeping it low. Under some circumstances, however, this type of polarisation may attain a considerable magnitude, examples of this were given.

The authors discussed irreversible phenomena at finite current densities, and at very small current densities. They then gave a theoretical interpretation of the results.

Electromotive Equilibrium and Polarisation, by A. Smits.

Though the phenomena of passivity and polarisation have been known for more than a century, one has not yet agreed on their explanation.

The presence of a film of oxide produced by chemical attack or anodic solution was first thought to be the cause of the passive state (Faraday). It was completely forgotten, however, that if in the passive state *such a film was present, the phenomenon of* the origin of passivity was not in the least solved. Take for instance the case of iron which, when dipped into strong nitric acid, first dissolves rapidly and then suddenly dissolves no more. In which state is the *iron covered by a film of oxide?* Why does iron dissolve at constant temperature in a solution of ferrous sulphate anodically up to a certain current density, following Faraday's law, and why at a current density but a little higher does the potential rise and oxygen is evolved, while the iron nearly ceases to dissolve? Further, we can ask, why is the potential of iron changed in the direction of that of the noble metals when it is dipped into a solution of a ferric salt, a change which is so large in a solution of ferric nitrate, that the iron becomes passive?

Why is this phenomenon dependent to so great an extent on temperature that, for instance, iron dipped into a solution of 0.14 gr. mol. $Fe(NO_3)_3$ per litre, remains active above 34°, but becomes passive immediately below 31°, and why have traces of halogen salts such an enormous influence on all these phenomena?

From this it follows that the cause of the phenomenon cannot be a film of oxide, but that it lies deeper.

Whatever be the final state of the metal; whether there be a film of oxide or something else, the primary phenomenon is that of passivity itself. At first, and indeed, even until quite lately, this was not generally understood.

All later theories have this in common that they assume as the cause of passivity the retardation of some process or other, which goes on when a metal is dissolved or precipitated. These theories can therefore be called *velocity-theories*, and they can be divided into the following groups:—

1. Theories which assume the formation of oxides as a result of a retardation.
2. Theories in which the cause of passivity is ascribed to the formation of an oxygen-charge or of a metal-alloy.
3. Theories in which hydrogen acts as an activating agent (Grave, Adler, Rathert).
4. Theories combining the hydrogen- and oxygen-charge hypothesis (Foerster).
5. Hydration-velocity theory (Leblanc).
6. Valency theory (Finkelstein, Müller).

Evidence, based on the study of the influence on the potential difference of small quantities of mercury dissolved in aluminium, is brought forward in support of an explanation based upon catalytic influence.

CORRESPONDENCE.

To the Editors of The Chemical News.

Sirs,—From time to time the non-technical journalist supplies, in all good faith, misleading information, and I fear that it is seldom possible to catch up with items of news which are widely circulated and which contain statements of dubious accuracy.

A paragraph recently circulated and quoted by the Technical Press refers to a violent explosion which set fire to and sank the British steamer "Otterburn." The paragraph concluded by saying that the

disaster was thought to be due to the explosion of barrels of chlorate of potash. I am informed, on what appears to be quite good authority, that there was no chlorate of potash on board the ship, but that there was a parcel of chloride of potassium.

The transport of dangerous substances is always a matter of difficulty, and it is therefore desirous that one should not unwittingly increase the difficulties by blaming a dangerous substance unnecessarily. To weigh down the statistics of explosions due to chlorate of potash by such items of news as that to which I refer would be misleading and prejudicial to those firms who have to send abroad such goods.—Yours, &c.,

W. J. U. WOOLCOCK,
General Manager.
The Association of British Chemical Manufacturers.
166, *Piccadilly, London, W.*1.
December 3, 1923.

NOTICES OF BOOKS.

The Electron in Chemistry, by SIR J. J. THOMSON, O.M., F.R.S. Pp. V. + 144 (with index). Messrs. J. B. Lippincott Company, Philadelphia, Penn. 1923. Price $1.75.

This book embodies the five lectures Sir J. J. Thomson delivered before the Franklin Institute in April, 1923; and it contains much new matter which Prof. Thomson had himself contributed to the subject of the electron in chemistry, etc., which had appeared in the *Philosophical Magazine* and elsewhere.

The main subjects dealt with are:—Arrangement of electrons in atoms; stability; periodic law; allotropic form; atomic size; ionisation potential; specific inductive capacity of gases; molecules; electron theory of valency; arrangement of electrons in octets; chains; chlorides, carbonates, etc.; residual affinity; molecular compounds; Werner's theory; electrolytic dissociation; mechanism of combinations; condensation on surfaces; double electrical layers; active molecules; Thiele's theory; Keto-enol change; production of light; homologous elements; variable valency; paramagnetism; diamagnetism; solids; crystals; vibration of electrons in crystals; compressibility; surface tension; intermetallic compounds, &c.

Of particular value is the bringing out of certain atomic and molecular attributes as due to the behaviour of electrons as revealed by positive-ray experiments and other phenomena, in connection with which Prof. Thomson is a pioneer investigator. The following are a few interesting features.

The proposed law of force between a positive charge and a negative electron is shown to lead to electrons in positions of stability round a nucleus without describing orbits round it.

The cubical theory of atoms and twisted cubes are discussed, but the latter is not drawn.

On page 3, Prof. Thomson says: "As up to the present nothing has been discovered that cannot be resolved into electrons and positively electrified particles, it is natural to frame a theory of the structure of the atom on the supposition that it is built up of these two ingredients. It should be borne in mind, however, that our means of detecting the existence of electrically charged bodies far surpass those for detecting uncharged ones, and if there were any uncharged constituents of the atom, they would in any case probably have escaped detection. We know, however, that even supposing such constituents do exist, their mass must be negligible compared with that of the positive parts, for these parts account for well within a fraction of a per cent. of the whole mass of the atom."

On page 26 it is pointed out "that on passing from one period to the next, the volumes of all the atoms are increased in the same proportion," thus:—

F = 1.35 A units in diameter.
Cl = 2.10
O = 1.30
S = 2.05; &c.
Then, by comparison:
Cl/F = 1.55.
S/O = 1.57; &c.

In the section (see page 39) dealing with combinations of different elements, it is noted that Thomson distinguishes between the molecule of carbon monoxide (CO) and that of the carbonyl radicle (CO). In the latter it is suggested that two out of the four electrons of the carbon atom have united with the oxygen to make up the octet, while the other two are free to join up with other electrons. In the same way there are two NO's.

On page 105, Prof. Thomson says of oxygen: "The most fascinating of all magnetic bodies is, to my mind, oxygen. Here we have one of the simplest of atoms; its atom contains only eight electrons, it is a gas, and therefore in the simplest of all physical states, and yet it alone of all gases is paramagnetic, and quite strongly so. An-

other remarkable thing about it is that innumerable as are the compounds of oxygen, there is only one, NO, into which oxygen carries its magnetic properties. This would seem to suggest that the magnetic quality does not arise from some quality intrinsic to the atom, but from some speciality in *the arrangement of the colligating electrons* in those molecules where it exhibits its magnetic character. The oxygen molecule itself is the most conspicuous example; the arrangement of the electrons may be represented symbolically as two cubes having a face in common, this face being at right angles to the *line joining the atoms.* If the system were rotating about this line there would be an odd number of square faces in rotation. A rotating square with its electrons would act like a current and thus behave like a magneton. Now, suppose that the rotation of electrons must be *such that adjacent squares rotate in opposite* directions, and it is evident that if we start one from rest in one direction, the adjacent one will start in the opposite direction. Suppose, then, that the electrons in the planes of the squares were rotating so that the rotation in one plane is *opposite to that in the adjacent plane, then* two of these planes will be rotating in one direction and the third in the opposite, the resuling magnetic effect will be the same as if only one plaue rotated, and this will produce a magnet of finite moment."

The above statement may be clear to some readers, but we think that a diagram showing the rotations would have been helpful in this case.

Paying tribute to Prof. Richards' work in respect of the compressibility of the elements, Prof. Thomson gives some calculations of the compressibility of metals based *on the supposition "that they are made up* of cubical cells with an atom and one-eighth of an electron [not, of course, a fractional electron] at each of its eight corners, each cell corresponding to an atom with its electron." This leads to a formula for k, the compressibility being $1/k$, which is—

$$k = (3.65/9)e^2 (\Delta/M)^{\frac{4}{3}}$$

e = charge of an electron;
M = mass of an atom;
N = *density of the solid;*
Δ = density.

For example, lithium is—

$\Delta = 0.534$;
$k = 0.114 \times 10^{12}$ calculated by above formula;
$k = 0.114 \times 10^{12}$ as observed by Richards.

Developing the subject further, in the *case of the diamond* $1/k = 0.178 \times 10^{-12}$, which agrees closely with the recent value of Adams (*Washington Acad. Sci.*, 1921, XI., p. 45), 0.16×10^{-12}.

Prof. Thomson's book is rich in suggestive ideas, and it should be widely read. There is only one feature in respect of its *get-up which we think could have been im*proved, and that is to have introduced a recapitulation at the end of each section or chapter, so that the reader would know where he stood in matters which may seem rather confusing, especially to those not steeped in the subject. The printing and binding is up to the high standard of book production as set by the most progressive publishing houses.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks and Designs can be obtained gratuitously.

Latest Patent Applications.

206229—Chance & Hunt, Ltd., Calder, W. A. S., and *and Palmer, W. H.—Process for condens*ing the acid fumes evolved during the concentration of sulphuric acid.

186589—Hansgirg, Dr. F.—Process and apparatus for the extraction of zinc from zinkiferous materials.

29313—Chemische Fabrik in Billwarder vorm., Hell & Sthamer Akt-Ges.—Manufacture of *puro anthracene and carbazol.* Nov. 20.

Specifications Published this Week.

206671—Stacey, F.—Electric apparatus for the production of peroxides of nitrogen.

206711—Lacy, S. A. De.—Frame to make possible, in the same apparatus, solvent recovery by distillation after extraction of a substance has been made by that solvent.

201914—Krupp Akt-Ges., F.—Articles requiring a high resistibility against corrosion by ammonium chloride solutions.

Abstract Published this Week.

204886—Chromium oxide and salts; chromates; barium chloride. — Chemische Fabrik Griesheim-Elektron, of 51, Gutleutstrasse, Frankfort-on-Main, Germany.

Alkali chromates; chromium oxides and salts: barium, chromium, and iron chlorides.—Chrome iron ore is converted into ferrochromium in the known manner, the ferrochromium is dissolved *in hydrochloric acid,* and the chromium precipitated as hydrated oxide by calcium or barium carbonate. The precipitate is separated and used to produce alkali chromate or chromium salts. The filtrate, if barium carbonate was used, is evaporated and cooled to separate barium chloride, and the mother liquor may be evaporated to obtain ferrous chloride. In the precipitation of the chromium hydrate it is preferred to use granular limestone or witherite and hot chloride solution.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

THE CHEMICAL NEWS,

VOL. CXXVII. No. 3323.

4′ AMINO 1 PHENYL 5 METHYLBENZOTHIAZOLE AND ITS BROMINATION IN GLACIAL ACETIC ACID, THE DIBROMO PRODUCT OF GATTERMAN AND THE FLUORESCENCE OF SOME BENZOTHIAZOLES.

By R. F. Hunter, F.C.S.

Gatterman, during his researches on 4′ amino 1 phenyl 5 methyl benzothiazole, observed that when the base is dissolved in glacial acetic acid and brominated, it adds two bromine atoms according to:

$$C_{14}H_{12}N_2S + Br_2 = C_{14}H_{12}N_2SBr_2.$$

Anschutz and Schultz, while working in the same field, observed the formation of similar compounds in the cases of the dehydrothioxylidins. We should expect the reaction observed by Gatterman to be:

$$CH_3C_6H_3 < \overset{S}{\underset{N}{}} > CC_6H_4NH_2 + 2Br =$$

$$CH_3C_6H_3 < \overset{S}{\underset{NBr}{}} > CBrC_6H_4NH_2,$$

that is to say to consist in the normal splitting of the double bond and the addition of bromine at the nitrogen and carbon atoms. The objection to this which has been raised is that in the above structure we have a bromine atom attached to a nitrogen atom directly, and that the compound should be very unstable and therefore tend to resemble nitrogen bromide in properties and stability to a certain extent. Whereas the compound is known to be quite stable at ordinary temperatures. It was therefore decided to prepare this compound and examine it. A further point to be observed is that if the interpretation given to the reaction is correct, then this reaction should be a general one and apply to all substituted benzothiazoles of this class. The recent researches which have been carried out on the derivatives of the base show that these brown products are formed whenever the thiazole is dissolved in glacial acetic acid and brominated in the manner described in the experimental part of this paper, some of the results have been communicated to the transactions of the Society of Chemical Industry, and a good many are as yet unpublished. Another point which was noticed during the investigation of these compounds was the remarkably fine fluorescence which some of them display in solution. This has been noticed previously by various workers. The effect is remarkably good when the substances are placed under the action of the ultra violet rays of a mercury lamp. Three derivatives were examined in this manner: the base itself in alcoholic solution, the acetyl derivative, and the dibromo product. The last two were used in the form of their solutions in acetic anhydride and glacial acetic acid respectively.

Experimental.

The 4′ amino 1 phenyl 5 methylbenzothiazole used in the experiments was prepared by the method described some time ago (*Trans. Soc. Chem. Ind.*, 1923, XLII., 302). The product was recrystallised from alcohol in the manner described in the original paper.

Dehydrothioparatoluidine Dibromide.—1 gm. of pure base is dissolved in 20 to 30 ccs. of pure glacial acetic acid in a 140 cc. beaker. Excess of bromine, according to the theoretical equation given above, is then added drop by drop from the burette containing bromine; the solution in the beaker is kept well stirred during the bromine addition; about 2 ccs. of bromine are added altogether. The first drop of bromine produces an immediate precipitate, which is of a dark red-brown in colour. The solution is then allowed to stand for twenty minutes, and then drowned in water (about 100 ccs. of cold water being added for complete precipitation). The precipitate is allowed to stand for a minute or two and then filtered, washed for some time with hot water and then with alcohol, dried, and then weighed. Yield, 1.3 gm.

The product, when dry, is a chocolate powder, as prepared above. It is soluble, as most of these compounds are, in xylene and in acetic acid. It was thought that it might be possible to diazotise the dibromo compound, and couple this with suitable couplers to form azo dyes, though such dyes would be rather unstable. Some of the compound was therefore dissolved in acid, and sodium, nitrite, nitrous acid, however, was found to split off bromine, the odour of bromine being quite distinct. Nitrous acid was also found to have a similar effect on the dibromo compound of benzaldehydro-

thioparatoluidine, which was also examined.

4′ amino 1 phenyl 5 methyl benzothiazole. A solution of the base in alcohol was exposed to a mercury lamp; the solution exhibits a beautiful green fluorescence.

The Dibromo product.—This was examined in a similar manner, using a solution of the substance in glacial acetic acid. The fluorescence was a beautiful blue colour. The introduction of the bromine atoms shifts the colour from the red end of the spectrum to the violet end.

4′-Acetylamino 1 phenyl 5 methylbenzothiazole.—A solution of this in acetic anhydride gave a bright, strong fluorescence.

The Imperial College of Science and Technology.

September, 1923.

ARE THE NATURAL GROUPINGS OF THE ELEMENTS AND THE SPECTRAL LINES OF HYDROGEN RELATED?

Part VII.

By F. H. Loring.

In further development of this study—see *The Chemical News*, 1923, CXXVII., pp. 225, 257, 273, 290, 337, 355, 369—attention is here drawn to an extension of the direct relations between the *group numbers* derived from the five Balmer lines and the distances of the various satellites from their respective planets.

In the main part of this investigation the planets Uranus, Jupiter, and Saturn will be dealt with, as these planets are particularly rich in satellites; and they consequently afford a range of values with which to test further the significance of the relationships thus far revealed for the first time, so far as the writer is aware.

The accompanying tabulations show the results of these findings, and they need no special explanation, except to state that the values under the letter C were obtained from a drawing given in the *Encyclopædia Britannica* (Planets), which gives the *relative* distances in an arbitrary scale. This was a desirable precaution to take at the outset, partly as a rough check against the other values obtained from Chambers' "Handbook of Astronomy" (1889), Vol. I., which are used here. Of course, the values (C) are only approximate.

It is important to specify all distances in terms of a common unit, in this case miles, M, so that the same reducing constant (K) can be used for each planetary system. S is the name of the satellite. N is the result of dividing M by K, while the corresponding group numbers derived from the Balmer lines are indicated by the letter B. D is the difference.

Uranus.

	S	C	M	K		N	B	D
1st	Ariel	(6.4)	124,700/19,310		=	6.46	7	+0.54
2nd	Umbriel	(8.9)	173,900		=	9.00	9	0.00
3rd	Titania	(14.3)	285,300		=	14.77	13	−1.77
4th	Oberon	(18.5)	381,600		=	19.76	21	+1.24

(+0.54) + (+1.24) = (+1.78), *which balances* (−1.77).

It will be seen that in the case of this planet, the satellite distances agree very *closely indeed with the B values.*

With regard to the derivation of the constant (K), if ΣM represents the sum of the satellite mean distances, and ΣB represents the sum of the group numbers (B), then ΣM/*n* (*n* being the number of satellites; in this case 4) divided by ΣB/*n* (*n* being the number of group numbers, also 4), gives the constant K here employed for systematic- [illegible] *reducing all satellite distances to a set* [illegible]parable figures. This calculation, [illegible]on the Uranus values, gives the

$k = 0.11$

Developin[illegible]

constant (K), which is applicable also to the satellites of Jupiter and Saturn, though in the latter case there appears to be a systematic error in respect of Rhea and Titan; but this may be due to the attempt to extend the Balmer values rather than develop the Paschen, or even the Lyman or Brackett, series (see Note 4 in Part VI. of this paper). In the instance of satellites much nearer to their planet (Mars) than any here shown, the Lyman series may give the proper values, but the examples are not numerous enough to afford a test that is so convincing as those being dealt with here.

JUPITER.

S	C	M K		N	B	D
1st. Io	(13.5)	267,300/19,310	=	13.84	13	-0.84
2nd Europa	(21.0)	425,100	=	22.01	21	-1.01
3rd Ganymede	(34.1)	678,300	=	35.12) *	48	
4th Callisto	(57.2)	1,192,800	=	61.72)		

* Mean = 48.42, giving D = (-0.42). A mean error for all the values is (-0.76), which is very satisfactory.

It should be noted that the first two terms of the series are absent in this case, as the relations do not indicate whether the lacunæ, so to speak, will or will not contain satellites, very much as with elements in the case of the periodic table.

SATURN.

S	C	M K		N	B	D
1st Mimas	(6.0)	115,100/19,310	=	5.95	—	—
2nd Enceladus	(8.0)	147,750	=	7.65	7	-0.65
3rd Tethys	(10.0)	183,000	=	9.46	9	-0.46
4th Dione	(13.3)	234,400	=	12.14	13	+0.86
5th Rhea	(18.6)	327,300	=	16.95	21	+4.05
6th Titan	(42.5)	758,700	=	39.30	—	—
7th Hyperion	(54.0)	916,700	=	47.48	48	+0.52
8th Iapetus	(124.5)	2,221,100	=	115.02	—	—

See remarks above *re* Rhea and Titan.

If, now, all the foregoing values corresponding properly to numbers 7, 9, 13, 21, 48, be grouped and averaged, the following results are obtained:—

$$(6.46 + 7.65)/2 = 7.05$$
$$(9.00 + 9.46)/2 = 9.23$$
$$(14.77 + 13.84 + 12.14)/3 = 13.58^{*}$$
$$(19.76 + 22.01)/2 = 20.88$$
$$(48.42 + 47.48)/2 = 47.95$$

* The moon's distance from the earth when reduced by the constant, K, gives the value 12.37. Averaging this value with 13.58 gives 12.97, which is practically 13. Then $\Sigma N = \Sigma B$.

Considering the wide range of phenomena represented, there seems to be no doubt whatever that the relations thus indicated in this series of papers are significant of some important law of far-reaching consequences; but it must be remembered that these studies are only first efforts in a new line of investigation.

SUMMARY.

In this paper it is shown that the distances from the satellites of Uranus, Jupiter, Saturn, and the Earth follow a planetary displacement law represented by the numbers 7, 9, 13, 21, 48, which are derivable directly from 5 Balmer lines of the hydrogen atom, spectrum, or from the 5 groupings of the periodic table of the chemical elements. These numbers also agree with the radial distances of 5 consecutive planets, measuring from the sun, counting the asteroids collectively as one member of the system. The question is raised as to whether one of the other line-series will likewise afford other values for the satellites much nearer their planets than those harmonised by this study, and also incidentally harmonise the irregularity in the case of Rhea and Titan. It is to be noted that there are 9 planets in the solar system, counting the asteroids collectively as one, so that some further development of one or the other of these series is to be expected, as the Balmer series only agrees with 5 members. *The point to be made, however, is that the values above given agree in many consecutive instances over a range of natural phenomena of almost incredible magnitude.*

NOTES.

Other Satellites:

Earth—

1 only. Moon. 238,900/19,310 = 12.37*

* Near to the value 13.

Neptune—

1 only. Lassell. 223,000/19,310 = 11.54*

* Mean between 9 and 13; but may belong to another series. Chambers mentions that this satellite is peculiar in its movement. It, of course, belongs to the most distant planet.

Mars—

1st Phobos 6,000) See remarks above
2nd Deimos 15,000) *re* other series.

Saturn—

The Balmer ζ line, by the formula, p. 291, gives 5.6, which is near to the value above for Mimas: 5.95. 62.5 may be used as a dividing constant instead of 61.5 for the whole series. A more recently-discovered satellite of this planet (Phœbe) has the probable *comparative* values as follows:—

7,798,300/19,310 = 403.83*

* This is outside the present range of calculations, and it would seem to involve another series as indicated above.

Jupiter—

A more recently-discovered satellite of this planet has the probable *comparative* values as follows:—

109,160/19,310 = 5.65*

* *Averaging this figure with that of* Mimas, 5.95, gives 5.80, the theoretical value being about 5.6.

These distances here are also in miles, as given above in the case of Uranus, &c.

DYESTUFFS (IMPORT REGULATION) ACT, 1920.

Applications for Licences in November, 1923.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during November, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 612, of which 485 were from merchants or importers. To these should be added 8 cases outstanding on November 1, making a total for the month of 620. These were dealt with as follows:—

Granted—433 (of which 413 were dealt with within 7 days of receipt).

Referred to British makers of similar products—119 (of which 105 were dealt with within 7 days of receipt).

Referred to Reparation supplies available—40 (all dealt with within 2 days of receipt).

Outstanding on November 30, 1923—28.

Of the total of 620 applications received, 558, or 90 per cent., were dealt with within 7 days of receipt.

GENERAL NOTES.

ATMOSPHERIC CORROSION OF METALS.

Future generations will express astonishment that right into the twentieth century we have been content to extend the use of constructional materials, without apparently giving any consideration to their relative corrodibility.

A small committee which could marshall the available scientific knowledge and apply the simplest of business costing principles, would almost certainly effect extraordinary changes in the choice of materials for building, public works, and innumerable engineering purposes. Much too little attention is usually paid to upkeep expenses in relation to initial cost of installation.

Comparing two metals, for instance; in the one case the initial cost may be less, but after the painting, repainting, repairing and perhaps even replacement are added, it may frequently prove much less economical than a second metal which can be used without any protective coating whatever.

The real problems of corrosion and their solution cannot, of course, be solved in this way, since much more fundamental knowledge of the causes and sequence of effects is required.

There seems to be no doubt that still *greater advances in the choice*, treatment, and use of materials, from the point of view of their resistance to corrosion, will result *from systematic observation* and experiments.

One of the most important researches on *the subject is that being carried out by* the Atmospheric Corrosion Committee of the British Non-Ferrous Metals Research Association. Mr. W. H. J. Vernon, B.Sc., the investigator, has just submitted his first experimental report, which was *read before the Faraday Society in London* on Monday, December 17. The work described has been carried out under the supervision of Professor H. C. H. Carpenter, F.R.S., at the Royal School of Mines, and dealt chiefly with the initial stages of corrosion—the tarnishing of metals. Quan*titative measurements* have been made on the relative behaviour of different metals and alloys, both indoors and outdoors. The subject is of immense importance, not only to those who are concerned in the manufacture of metal fittings and articles, but in its direct relation to labour-saving in daily housework.

The investigation was by no means confined to tarnishing, which formed the outstanding feature of the first report, merely because it represented the initial stage of corrosion. Exposure tests to outside atmospheric influences have been progressing since the commencement of the research, and will doubtless yield their quota of evidence in due course.

The extension of this work depends to a large extent on the support given to the British Non-Ferrous Metals Research Association for this specific purpose; the investigation already has the backing of the Royal Institute of British Architects, the Department of Scientific and Industrial Research, and many of the leading firms and associations in the metal industry.

THE WORLD'S WHEAT SUPPLIES AND REQUIREMENTS.

According to an estimate made by the International Institute of Agriculture, at Rome, the wheat-exporting countries are theoretically in a position to furnish to the importing countries during the cereal season from August 1, 1923, to July 31, 1924, about 570 million centals of wheat. To this quantity Canada could contribute about 221 million centals, the United States a little over 112 million, India 12 million, Argentina 122 million, Australia 55 million, while the Balkans, Hungary, Russia, and the French colonies in North Africa could furnish altogether about 45 million centals.

Estimates of probable requirements in the importing countries are not at all easy to prepare for the current season, owing to recurring difficulties presented by the financial and economic conditions existing in sundry European States and by the efforts of some Governments to limit imports of foreign wheat. In pre-war times it might generally be assumed that individual consumption in a given country would not vary much from year to year. Having ascertained the quantity produced in a certain country during a stated season, it was possible to define with fairly close approximation the quantity of wheat required to supplement home production during the twelve-month.

Now, however, the basis for such an estimate has become much less secure, and it by no means follows that a short crop entails a correspondingly larger import, or *vice versa*. There is proof of this in effecting comparison between data of production and imports, for the two seasons 1921-22 and 1922-23 respectively.

Although the 1922 crops in importing countries were 110 million centals less than in 1921, these countries took, between August 1, 1922 and July 31, 1923, much the same quantity of foreign wheat. For the most part the causes leading to such a decline in consumption are still in operation. Even if the plentiful yields so general in 1923 should result, for some countries, in a larger consumption than last year's, it seems probable that import requirements between August 1, 1923, and July 31, 1924, will be on a more restricted scale than those of last season. In any event, these imports are unlikely to exceed last year's total of 430 million centals.

To sum up:—

(1) The quantity of wheat that theoretically might be despatched by the exporting countries to the importing States between August 1, 1923 and July 31, 1924, is about 570 million centals.

(2) The quantities required for the same period by importing countries to supplement their home production may reach 430 million centals at most, but it is improbable that this figure will be attained.

(3) The quantity available in exporting countries will therefore suffice to meet the requirements of the importing countries until the next harvest in the northern hemisphere, and to leave a surplus on hand at August 1, 1924. This surplus may be estimated at not less than 140 million centals.

DRUGS, CHEMICALS, ETC., FOR EGYPT.

The British Commercial Agent for Egypt has forwarded to the Department of Overseas Trade copies of documents issued by the Egyptian Ministry of the Interior in connection with a call for tenders for the supply of miscellaneous drugs, chemicals, etc., required by the Department of Public Health during 1924-25. The schedule of stores required includes:—

(1) Proprietary articles;
(2) Druggists' sundries;
(3) Surgical dressings;
(4) Crude drugs and heavy chemicals;
(5) Fine chemical products; and
(6) Galenicals and packed articles.

Tenders will be received by the Director of Stores, Department of Public Health,

Cairo, up to noon on January 14, 1924. Article 5 of the conditions of tender states that "the articles supplied must be exactly similar to the standard sealed pattern, kept at the Central Stores, Department of Public Health, Cairo, and in number, weight, and measurements in accordance with the written schedule or size roll given to the contractor by the Director of Stores. The standard pattern will be sealed by the Department and by the contractor." It is also stipulated that the tenderer must be a person residing in Egypt, or must have a representative there, and will give in his offer an address at which notices may be served upon him. The Department of Overseas Trade will furnish U.K. firms desirous of tendering and not represented locally with the names and addresses of United Kingdom merchant firms established in Egypt, who would be prepared to handle tenders on their behalf.

A copy of the schedule of stores required, conditions and form of tender, may be seen on application, while a further set of these documents is available for loan to firms in the provinces who may be unable to arrange for a London representative to call here.

GERMANY'S COMMERCE AND INDUSTRY DURING NOVEMBER.

Mr. J. W. F. Thelwall, H.M. Commercial Secretary at Berlin, has forwarded to the Department of Overseas Trade a review on the state of Germany's trade and industry during November.

No improvement occurred in the economic situation in November. The position in occupied territory continued hopeless. Its economic life, with a few exceptions, remained stagnant. There the possibilities of export diminished more and more, while imports of such raw materials as were formerly produced in the country increased. Unproductive work became more extensive, an exceptional rise in the costs of production occurred, and the level of prices for goods was generally very high.

Mining.

The pit-coal production in Upper Silesia was again interrupted. The small output of the preceding month was, therefore, scarcely exceeded. There was no complaint as to the supply of trucks. In spite of a reduction of advance freights by the railway and of reduced shipping rates, there were practically no consignments to places of transhipment. The demand revived as compared with last month owing to the more pressing requirements at this time of the year of agriculture, household coal consumers and gasworks. As before, however, the orders for dust coal were not extensive.

In the Central German brown coal district the market conditions continued unfavourable, so that shifts had to be dropped in many mines, although after the last strike a fairly considerable number of workers were not reinstated. In some works the number had been reduced by 15-45 per cent. Other works had not yet started operations again after the strike.

In the Ruhr coal district all the miners and employees were given notice of termination of work on November 30 and December 31 respectively.

Potash.

In the potash industry, with the exception of a somewhat more lively export of sulphates to North America, the market was very unfavourable. Further shifts had consequently to be dropped in all the works, and dismissals had partly to be resorted to. Inland business became more and more paralysed. It is hoped, however, that after the introduction of a sufficient quantity of stable media of payment, the main difficulty in the purchase of potash salts will be overcome. The demand, particularly from abroad, for chemical by-products, was still satisfactory. In order to offer an incentive to the immediate placing of orders for potash, the Potash Syndicate, in agreement with agricultural and trade organisations, granted a goods discount to consumers. In spite of this, however, only small orders were placed on behalf of agriculture, so that, next to April, November was the most unfavourable month of this year as far as sales were concerned.

Metals.

The metal trade was at times brought to a standstill, as the position on the metal market grew continually worse. The decree, issued at the end of October, again prohibiting free transactions in foreign values and the action taken at the same time by the Reichsbank to support the mark, resulted in a very important difference between the inland and foreign mark rates. The metal trade was thereby greatly hampered, and the fixing of uniform metal prices was impossible. For this reason the Berlin Metal Exchange again ceased to issue quotations.

Chemical Industry.

The general economic situation necessitated further restrictions of work in the chemical industry in occupied territory. If uninterrupted communication with unoccupied Germany is not made possible, the works must come to a total standstill. In the chemical preparations industry the demand for laboratory chemicals was very small, and, that for glass chemicals diminished in the degree in which the glass-works were compelled to restrict work or close down. The demand from abroad also fell off as sale prices approached the world's market level. It is felt to be a particular burden that just at the present time the refunding of the British Reparation Levy should have been discontinued, and thus all possibility of selling German products to England removed. It is all the more to be regretted, as French competition is greatly felt in England, and will now secure the whole trade without effort. A slight revival of both inland and foreign trade in the remaining chemical preparations was reported.

Glass Industry.

In the sheet glass industry there was no improvement on the inland market. The demand from abroad increased somewhat, but prices were so depressed owing to Czecho-Slovakian and Belgian competition that they scarcely covered much more than half the costs of production. Wage strikes interfered with production in the hollow-glass industry. The advance in the costs of production, which made competition abroad impossible, led to further restrictions of work and the closing down of factories.

Ceramic Industry.

The position of the porcelain industry became considerably worse, and was characterised by a complete stagnation in inland sales, numerous cancellations of orders, and restriction of operations. Restricted operations were reported from the Palatinate, Wurttemberg, Thuringia, Saxony, Silesia, and Brandenburg. The electro-technical porcelain industry suffered from a great lack of orders and from short-time work. Only the glazed wall-tile factories were, in part, well employed.

Paper Industry.

The degree of employment in the paper industry was, in general, not unfavourable as compared with other branches of industry. By the middle of October, however, the number of unsatisfactorily employed works which had to curtail working hours or work for stock preponderated. Since then the position has grown considerably worse. The financial difficulties (growing costs of production, diminishing receipts owing to falling off of sales, restriction of credit and the difficulty of obtaining the latter from the banks) increased continually, and the stock of orders was reduced. According to one report from an industrial association, in land trade was practically at a standstill. The raising of even the most necessary funds for raw materials, wages and salaries, etc., met with the greatest difficulties. In order to maintain the factories, the industry is more than ever dependent on exports. In the paper producing and working up industry, the possibilities of export in general declined more and more, owing to excessively high prices. For the rest, the conditions as regards production were not unfavourable, especially for the paper raw material industry. The water conditions improved, and sufficient German coal was obtainable (the demand having fallen off in view of restrictions of work), though it was, in part, more expensive than British coal. The supply of auxiliary materials, witb the exception of dyes, was adequate. The production of wood-pulp increased, but the demand was generally small.

Leather Industry.

The prices of hides and skins rose considerably, owing to the further depreciation of the mark. With a few exceptions, the pre-war prices have not only been reached, but exceeded. A more wholesome demand on the part of manufacturers was recorded. The turnover would have been greater, had it not been for money difficulties. In the leather trade business was almost stagnant in the first part of the month, owing to the lack of money; hut here also a more wholesome demand set in subsequently, although an important turnover could not be achieved in consequence of the difficult position as regards currency. As before, complaint was made in the boot and shoe industry as to the lack of purchasing power on the part of the public. A better turnover was, however, obtained in the retail trade.

Sugar Industry.

Lively business in sugar (for consumption) from the new harvest developed in the course of the month. The reports regarding the proposed export by the Government of sugar and regarding the estimated harvest yield (the latter is estimated to be about 20 per cent. smaller than last year) called forth a brisk demand for sugar. The

factories, however, placed only comparatively small quantities on the market. The result was an increase in prices, so that inland prices habe now exceeded the world's market level, although the latter has also advanced considerably. The sugar working up industry continued to complain of a strong decline in business owing to too high prices, and also, in particular, of a great shortage of sugar. so that short time work and dismissals frequently became necessary.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY OF ARTS.

On Monday, December 10, the Cantor Lecture (II.), entitled *Recent Progress in the Wool Industries*, was read by ALDRED F. BARKER, M.Sc., Professor of Textile Industries, the University, Leeds.

On Wednesday, December 12, at the Ordinary Meeting, a paper entitled *The Preservation of Historic Buildings and Ancient Monuments* was read by SIR FRANK BAINES, C.B.O., C.B.E., Director of Works, H.M. Office of Works. Sir Aston Webb, K.C.V.O., C.B., C.R.A., Vice-President of the Society, presided.

The Dominions and Colonies Section held a meeting on Monday, December 17. A lecture entitled *Empire Settlement* was delivered by WILLIAM C. NOXON, Esq., Agent-General for Ontario. The Right Hon. the Earl of Airlie, M.C., presided.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

ORDINARY MEETING.

Held at the Chemical Society's Rooms, Burlington House, on Wednesday, December 5, 1923, Mr. P. A. Ellis Richards (President) in the chair.

Certificates were read for the first time in favour of:—Messrs. Frank Knowles, Archibald Knox, A.I.C., Charles Roger Middleton, B.Sc., A.R.C.S., D.I.C., A.I.C., Harold Richard Read, A.I.C., George Hogan, F.I.C., Thomas Francis Doyle.

Certificates were read for the second time in favour of:—Messrs. Robert Charles Frederick, Hubert Thomas Stanley Britton, M.Sc. (Lond.), F.I.C.

The following were elected members of the Society:—

Messrs. Laurence Eversley Campbell M.Sc. (Lond.), F.I.C., John Troubridge Hannen, B.A. (Cantab.), A.R.C.Sc., A.I.C., Cyril Langley Hinton, F.I.C., Douglas William Kent-Jones, M.Sc. (Lond.), F.I.C., Thomas William Alan Shaw, M.Sc. (Liv.), William Hall Simmons, A.I.C., Kenneth Edward Nethercoate Williams, Percy Noel Williams, M.Sc (Liv.), A.I.C.

The followng papers were read:—

The Crystalline Bromides of Linseed Oil, by HAROLD TOMS, M.Sc., A.I.C.

The "insoluble bromide" of linseed oil, first described by Hehner and Mitchell, appears to consist of mixtures in varying proportions of two crystalline bromides, viz.: (1) a linolic-dilinolenic bromo-glyceride, and (2) the trilinolic bromo-glyceride of the oleic-linolic-linolenic bromo-glyceride. These two bromo-glycerides have been obtained in pure condition by crystallisation from ethyl acetate. They melt at 153° C. (corr.) and 117° C. (corr.), respectively. The solubility of the more insoluble bromide in ethyl acetate lies between 0.15 and 0.20 grm. per 100 cc. at 15 to 20° C. The methods of estimating the bromine in these compounds have been studied, and it is shown that theoretical results can be obtained by the method of Carius and by a modification of the method of Stephanow, but not by the lime method. Various methods of estimating the more insoluble crystalline bromides are described, the yields of the purest product varying from 9.39 to 11.6 per cent. in the case of different oils. The results obtained suggest that there is some relationship between the yield of this crystalline bromide and the iodine value of the original oil.

The Plea for Standardisation, by M. S. SALMON, B.Sc.

The author emphasises the fact that in every field of analytical chemistry instances are continually occurring where different, although well recognised methods of analysis yield varying results. He refers in particular to the case of dried milks, and instances one example where one sample of dried milk was sent to four well-known analysts, and a considerable divergence of figures resulted according to the methods used, particularly in the case of the fat and lactose estimations.

Referring next to essential oils, the need for standardisation is seen to be urgent, for in many cases minute modifications in detail cause substantial differences in results. The same remarks apply to the case of inorganic materials of simpler composition, and the author sees a recognition of the difficulties in the details laid down for analyses under the Fertiliser and Feeding Stuffs Act, and he strongly advocates the formation of a Committee to consider the whole question.

A Note on the Estimation of Chromium, by HUBERT T. S. BRITTON, M.Sc., F.I.C.

The gravimetric methods of estimating chromium as oxide are discussed. Whatever precautions are taken to use only the purest reagents and salts, and platinum crucibles, the ignited oxide is always found to contain some chromate. This may be shown by extracting with water. Hence, such methods lead to high results. It has been found that chromium can be quickly and accurately estimated volumetrically. The procedure is to add to an approximately neutral solution of a chromium salt an excess of sodium peroxide—about a gram—and boil for ten minutes to complete the oxidation to chromate and to decompose the unused peroxide. After acidification with either sulphuric or hydrochloric acid, excess of potassium iodide is added, and the liberated iodine titrated in the usual way.

The Colorimetric Estimation of Lead in Cream of Tartar, by R. L. ANDREW.

During 1921-22 all importations of cream of tartar to New Zealand were examined for lead, and the following method was found to give similar results and to be less cumbersome than the B.P. method. One cc. of 5 per cent. potassium cyanide solution, 1 cc. of ammonia solution, and 40 cc. of water are added to two grams of cream of tartar, and soultion effected by warming and shaking. After cooling and filtering, any tint is matched in the standards hy the addition of very dilute caramel. These standards are prepared in a similar way from 2 grams of lead, free from cream of tartar, with the addition of requisite amounts of lead nitrate solution containing 0.01 per cent. of lead. A few drops of 10 per cent. sodium sulphide solution are added, and the solutions are all made up to the mark and the amount of lead estimated by comparison. If a standard water solution of lead is used, a serious error is introduced; as the colour is only about half the depth of that produced with a tartrate solution, and the effect of ferric and ferrous iron is investigated.

THE SOCIETY OF GLASS TECHNOLOGY.

A meeting of the Society of Glass Technology was held in University College, Gower Street, W.C.1, on December 12.

The following papers were received and discussed:—

An Apparatus for the Calibration of Burette Tubes, by VERNEY STOTT, B.A., F.INST.P.

Some Factors Affecting Efficiency in the Glass Trade, by ERIC FARMER, M.A. (Industrial Fatigue Research Board).

Specifications in the Glass Industry, with Special Reference to Soda-Lime Glasses for Containers, by PROFESSOR W. E. S. TURNER, D.Sc.

THE PHYSICAL SOCIETY OF LONDON.

A meeting of the Society was held on Friday, December 14, at the Imperial College of Science, South Kensington, S.W.

The following papers were read:—

The Aerodynamic Resistance of Spheres Shot Upward to Measure the Wind, by L. F. RICHARDSON, F.INST.P., F.R.MET.SOC.

X-Ray Analysis of Zinc-Copper Alloys, by E. A. OWEN, M.A., D.Sc., and G. D. PRESTON, B.A.

Investigations of Piezo-Electric Effects with Dielectrics, by K. R. BRAIN, B.Sc.

A Demonstration of "The Neon Tube Oscillograph" was given by H. St. G. Anson.

THE OPTICAL SOCIETY.

A meeting was held at the Imperial College, South Kensington, on Thursday, Dec. 13. The following papers were presented and discussed:—

The Primary and Secondary Constant Magnification Surfaces of Thin Lenses, by T. Smith, M.A., F.Inst.P.

A Suggested Standard Trial Case and Simplification in Ophthalmic Policy, by W. Swaine, B.Sc.

"An optical revolution counter" was exhibited and described by B. K. Johnson.

PROCEEDINGS OF THE GEOLOGICAL SOCIETY OF LONDON.

December 5.

Prof. A. C. Seward, Sc.D., F.R.S., President; and, afterwards, Dr. G. T. Prior, F.R.S., F.G.S., in the chair.

Dr. F. A. Bather exhibited, on behalf of Mr. A. S. Hirst, F.Z.S., specimens, microscope-slides, and lantern-slides of Arachnid Remains from the Rhynie Chert, and described their structure and affinities.

The following communications were read and discussed:—

The Geology of the Northern Border of Dartmoor, between Whiddon Down and Butterdon Down, by Charles William Osman, M.Inst.C.E., F.G.S.

The Geology of Southern Guernsey, by Donald John Farquharson, M.Sc., F.G.S.

Rock-specimens and microscope-sections were exhibited by Mr. C. W. Osman, and microscope-sections were exhibited by Mr. D. J. Farquharson, in illustration of their respective papers.

A meeting of the Society was held on Wednesday, December 19.

Prof. W. J. Sollas, F.R.S., F.G.S., demonstrated the Method of Investigating Fossils by means of Serial Sections, and exhibited some of the results obtained.

Mr. John Walton, M.A., dealt with the Investigation of the Nature of Fossil Plants, illustrating his remarks by lantern-slides.

THE ROYAL INSTITUTION OF GREAT BRITAIN.

Lectures Before Easter, 1924.

Friday Evening Discourses, addressed to members and their friends, at 9 p.m.:—

Jan. 18: Prof. Henry E. Armstrong, LL.D., F.R.S., M.R.I., *The Scientific Work of Prof. Sir James Dewar, LL.D., D.Sc., F.R.S., Fullerian Prof. of Chemistry* (1877-1923).

Jan. 25: Sir Aston Webb, K.C.V.O., C.B., President of the Royal Academy, *The Future Development of London.*

Feb. 1: Sir William Bragg, K.B.E., D.Sc., F.R.S., M.R.I., Fullerian Prof. of Chemistry, *Recent Research on Crystalline Structure.*

Feb. 8: Sir Arthur Evans, D.Litt., LL.D., F.R.S., F.S.A., Prof. of Prehistoric Archæology, University of Oxford, *Recent Lights on the Minoan Art of Crete.*

Feb. 15: J. H. Jeans, LL.D., D.Sc., F.R.S., M.R.I., Secretary of the Royal Society, *The Origin of the Solar System.*

Feb. 22: G. Elliot Smith, M.D., F.R.S., F.R.C.P., M.R.I., Prof. of Anatomy, University of London, *The Human Brain.*

March 7: Walter Rosenhain, D.Sc., F.R.S., Superintendent of Metallurgy Department, National Physical Laboratory, *The Inner Structure of Alloys.*

March 14: J. W. Mackail, LL.D., F.B.A., Hon. Fellow of Balliol College, Oxford. *"The Pilgrim's Progress."*

March 21: Sir Frederick Keeble, C.B.E., Sc.D., F.R.S., Sheradian Prof. of Botany and Fellow of Magdalen College, Oxford, *The Plant Commonwealth and its Government.*

March 28: Hugh Maclean, M.D., D.Sc., Prof. of Medicine, University of London, *Insulin.*

April 4: Sir Ernest Rutherford, LL.D., D.Sc., F.R.S., M.R.I., Prof. of Natural Philosophy and Cavendish Prof. of Experimental Physics, University of Cambridge, *The Nucleus of the Atom.*

April 11: Jocelyn Thorpe, C.B.E., D.Sc., F.R.S., Prof. of Organic Chemistry, Imperial College of Science and Technology, *Colours, Stains and Dyes.*

Juvenile Christmas Lectures—Three O'clock, Afternoon.

Concerning the Nature of Things, by Sir William Bragg, K.B.E., D.Sc., F.R.S., M.R.I., Fullerian Prof. of Chemistry.—

Ninety-Eighth Course, adapted to a Juvenile Auditory (Illustrated):—

(I.) *The Atoms of which Things are Made;* (II.) *The Nature of Gases;* (III.) *The Nature of Liquids;* (IV.) *The Nature of Crystals: The Diamond;* (V.) *The Nature of Crystals: Ice and Snow;* (VI) *The Nature of Crystals: Metals.*

(I.) Thursday, Dec. 27; (II.) Saturday, Dec. 29; (III.) Tuesday, Jan. 1; (IV.) Thursday, Jan. 3; (V.) Saturday, Jan. 5; (VI.) Tuesday, Jan. 8.

GENERAL COURSES OF LECTURES BEFORE EASTER, 1924.

Tuesdays and Thursdays at 5.15 p.m.; Saturdays at 3 p.m.:—

Tuesdays, Jan. 15, 22: *Drug Addictions*, by WALTER E. DIXON, M.D., F.R.S., Prof. of Pharmacology, King's College, London.

Tuesdays, Jan. 29, Feb. 5: *What is Heredity?* by ARTHUR DENDY, D.Sc., F.R.S., Prof. of Zoology, University of London (King's College).

Tuesdays, Feb. 12, 19, 26, March 4: *The Respiratory Pigments in Animal Life and Their Significance*, by JOSEPH BANCROFT, C.B.E., F.R.S., Fellow of King's College, Fullerian Prof. of Physiology.

Tuesdays, March 11, 18: *Recent Investigation Concerning the Safety of Railway Bridges*, by MAJOR C. E. INGLIS, O.B.E., M.A., A.M.INST.C.E., Prof. of Engineering, University of Cambridge.

Tuesdays, March 25, April 1, 8: *Ballads*, by GEORGE GORDON, Merton Prof. of English Literature, University of Oxford.

Thursdays, Jan. 17, 24, 31: *Straws from Cumberland Market*, by WALTER SICKERT.

Thursdays, Feb. 7, 14, 21, 28: *The Crystalline Structure of Organic Substances*, by SIR WILLIAM BRAGG, K.B.E., D.Sc., F.R.S., M.R.I., Fullerian Prof. of Chemistry.

Thursdays, March 6, 13: I., *Modes of Volcanic Action;* II., *Types of Volcanic Structures*, by JOHN S. FLETT, D.Sc., LL.D., F.R.S., Director of H.M. Geological Survey and Museum of Practical Geology.

Thursdays, March 20, 27: *Evolution To-Day*, by D. S. M. WATSON, M.Sc., Jodrell Prof. of Zoology and Comparative Anatomy, University of London.

Thursdays, April 3, 10: *Scientific Research on Sea Fisheries*, by E. J. ALLEN, D.Sc., F.R.S., Secretary of the Marine Biological Association and Director of the Plymouth Laboratory.

Saturdays, Jan. 19, 26, Feb. 2: I., *The Mechanical Reproduction of Music*, by REGINALD REYNOLDS, A.G.S.M. (with musical illustrations); II., *The Couperin Dynasty;* III., *The Influence upon Composition of Improvements in Musical Instruments*, by WILLIAM WALLACE (with musical illustrations).

Saturdays, Feb. 9, 16: *The Last Years of the Scottish Parliament*, by ROBERT S. RAIT, C.B.E., LL.D., Historiographer Royal for Scotland.

Saturdays, Feb. 23, March 1: I., *Imaginative Prose;* II., *Character in Fiction*, by WALTER DE LA MARE.

Saturdays, March 8, 15, 22, 29: *Properties of Gases in High and Low Vacua*, by SIR ERNEST RUTHERFORD, LL.D., D.Sc., F.R.S., M.R.I., Prof. of Natural Philosophy, R.I., and Cavendish Prof. of Experimental Physics, University of Cambridge.

Saturdays, April 5, 12: I., *Aristotle as a Biologist;* II., *Leonardo da Vinci as a Man of Science*, by CHARLES SINGER, D.LITT., M.D., F.R.C.P., Lecturer on the History of Medicine, University of London, University College.

THE FARADAY SOCIETY.

First (Experimental) Report to the Atmospheric Corrosion Research Committee (of the British Non-Ferrous Metals Research Association), by W. H. J. VERNON, B.Sc., read on Monday, December 17.

The research has proceeded mainly along two lines. "Field Tests" have been carried out with relatively large specimens exposed to representative atmospheres, with the primary objects of (*a*) comparing the effects of these atmospheres upon typical metals and alloys, and (*b*) correlating the behabiour, among themselves, of as wide a range of materials as possible. Laboratory experiments, on the other hand, were conducted upon relatively small specimens, with the object of obtaining information concerning the mechanism of atmospheric corrosion.

The work was divided into two parts, devoted respectively to these main branches of the work. Although much the greater amount of time has been expended in the former direction, actually the results so obtained have contributed largely to the object envisaged by the latter; for this reason the distinction between the two parts has not been retained in summarising the re-

sults. It should be stated that in consequence of the comparatively early stage which it represents, the present report is occupied, in the main, only with the phenomenon of *tarnishing*, as distinct from corrosion in the ordinary sense.

The types of atmosphere investigated included (1) an indoor atmosphere maintained continuously in the unsaturated condition with respect to water vapour. (2) An indoor atmosphere of variable (but relatively high) humidity, occasionally reaching saturation. (3) An ordinary domestic kitchen. (4) Open-air exposure (at South Kensington).

The methods of examining and estimating tarnish films were: (1) Visual (supplemented, as occasion required, by the microscope). (2) Optical. After suitable preparation, the *reflectivities* of metal surfaces have been determined, (*a*) in the freshly-cleaned condition, (*b*) during the course of exposure. The loss of reflectivity affords a very sensitive means of estimating the changes taking place at the surface, applicable more particularly to the earliest stages of tarnishing. (3) Gravimetric. Accurate determinations have been made of the *increase in weight* of the test-plates, at intervals during the whole period of indoor exposure, and also in the very early stages of open-air exposure. In the case of indoor conditions, interesting relationships have been found to obtain between weight-increment and period of exposure.

The significance of the shape of the curve obtained by plotting weight-increment against time was discussed in relation to the function of the corrosion product or "scale," and the principle involved appears to be of much importance. Three types of curve have been distinguished:

(1) A *parabola* whose axis coincides with the *time-axis of co-ordinates*. Weight-increment is thus proportional to the square root of time, *i.e.*, the rate of attack is retarded as the period of exposure increases. The *scale* forms a continuous envelope, the rate of diffusion of the corroding atmosphere through which regulates the attack upon the underlying metal. *Example*: Copper, within a wide range of humidity conditions.

(2) A *straight line* passing through the origin. Weight-increment is directly proportional to time, *i.e.*, the rate of attack remains constant as the period of exposure increases. The *scale* is completely permeable, allowing free access of atmosphere to the metal, and itself playing a neutral part. *Example: Zinc, in an unsaturated atmosphere.*

(3) A *parabola* whose axis coincides with the *weight-axis* of co-ordinates. Weight-increment is proportional to the square of time, *i.e.*, the rate of attack is accelerated as the period of exposure increases. The *scale* is discontinuous, and accelerates the attack upon the remaining metal in proportion to the amount which is already present. *Example*: Iron in an atmosphere of relatively high humidity, intermittently reaching saturation.

Whilst no appreciable difference has usually been observed by ordinary visual examination between the behaviour of emeried and brightly-polished surfaces respectively, the optical and gravimetric methods have shown under certain conditions a greater degree of tarnishing on the rougher surface. Under "inside" conditions the maximum differences have been observed in the atmosphere of low relative humidity. In the more humid atmosphere, "dull" and "bright" surfaces have given practically identical results (both as regards weight-increment and percentage loss of reflectivity).

In the atmosphere of the kitchen, anomalous results have been observed, particularly with silver and silver-copper alloys, fine silver then showing, by *all* methods of examination, a greater degree of tarnish on the *polished* surface; on the other hand, in the case of the standard alloy, the normal result obtains but to an exceptional and excessive degree, the brightly-polished surface then being relatively immune from attack.

In all instances investigated the difference in behaviour between materials having the maximum degree of hardness and of softness respectively has been exceedingly small—always below the limits of visual detection, and frequently incapable of estimation even by the optical method. Wherever an appreciable difference has been recorded, however, the harder material has always been found to have undergone the greater amount of change; the difference is more readily detected with dull-polished (emeried) than with brightly-polished specimens.

A considerably greater degree of tarnishing obtains during the winter than during the summer months, even in an indoor atmosphere in which no combustion processes are carried on, the difference being due pre-

sumably, to the greater pollution of the atmosphere during the former period. Moreover, the incidence of cold spells of weather is also accompanied by an increase in the rate of tarnishing, due doubtless to the same cause. It is important to note, however, that these remarks refer to initially-clean surfaces exposed during the periods concerned. With copper, and copper-rich alloys, the rate of tarnishing is controlled (within a wide range of atmospheric conditions) by the nature of the tarnish film which is initially formed.

THE INSTITUTION OF PETROLEUM *TECHNOLOGISTS.*

Paper read at the Royal Society of Arts, on December 11:

The Modern Rotary Drilling System, by L. R. McCollum.

The percussion, or cable tool method of drilling, which Col. Drake first used in 1859, has changed but little in principle.

It has proved a reliable method for drilling in most fields, and its use has been widespread throughout the United States, and in many foreign fields.

Later, exploitation work in the Gulf Coast regions of Texas and Louisiana encountered unconsolidated, soft, and caving formations, which gave the cable tools a bad time. To combat these conditions the Rotary system was invented, or rather developed, upon the Fauck system, which had been in use in Europe since 1845.

By this method a rigid stem of pipe rotates a fish tail—or other type of bit—at the bottom of the hole, being assisted by the action of clay mud in the fluid state, pumped under hydraulic pressure, through the drill pipe. The circulating mud also removes the cuttings from the hole.

So great were its virtues of speed and economy that modifications and improvements were soon added which enabled it to penetrate thick strata of extremely hard rock at great depths. This capacity has now been probed beyond the questioning of intelligent operators.

The extreme speed attained with this type of equipment, and the few strings of casing necessary, are its chief assets.

One of the objections which is raised against the Rotary system by operators unfamiliar with its working, is that there is the danger of mudding off unknown oil sands, but it was pointed out that this risk was very small and could be overcome.

The author went on to describe the principle and accessories of the system, and dealt with such matters as mud storage, power, pumps, the actual operation and speed attainments. The advantages of the method were well brought out.

The Library of the Chemical Society will be closed for the Christmas holidays from Monday, December 24, to Thursday, December 27, inclusive.

NOTICES OF BOOKS.

Valence and the Structure of Atoms and Molecules, by Professor G. N. Lewis. Pp. 172. 1923. The Chemical Catalog Company, 19, East 24th Street, New York, U.S.A. (American Chemical Society Monograph Series). Price $3.00.

Prof. G. N. Lewis, the pioneer in the structure of atoms and molecules as based upon electrons arranged at the corners of cubes, has written a monograph of considerable value. Of particular historical interest in this connection is a reproduction of his original sketches of atoms, as made in 1902.

This book is in the nature of a survey, in which some of the present-day theories of the atom are clearly expounded. It seems a little extraordinary that so much space should be given up to the Bohr atom, seeing that Prof. Lewis was the originator of a theory quite as interesting and valuable; but this is no doubt done in a spirit of fairness, though one might have expected the pioneer of the octet theory to have given his whole attention to its elucidation and expansion as developed by other workers.

Referring to the attempt to co-ordinate the static theory with the dynamic, this, as far as expounded by Prof. Lewis, cannot be said to be at all successful, but this comment is not in the nature of an adverse criticism, since one is compelled to make the most of co-ordination ideas in books of this type.

Many of the more or less usual introductory statements appear, but the implication that Helmholtz, in 1881, was the first to make important observations that electricity was atomic in character is not historically true. Wilhelm Weber, in 1871, introduced in his theoretical work the idea of particles of positive and negative electricity, and went so far as to postulate that the + particle described an orbit round the − particle, thus indicating the "Amperian

molecular current,'' to quote his words. In 1874, G. Johnstone Stoney, at Belfast, read a paper (printed later), in which the elementary electrical charge was clearly enunciated, and an attempt was made to evaluate its magnitude which approximated to the truth; and, moreover, Prof. Stoney, in 1891, designated this charge by the name *electron*. The later work of H. A. Lorentz is not mentioned. The reviewer does not presuppose that Prof. Lewis was unaware of these matters, but the omissions are, nevertheless, apparent: an oversight, no doubt.

On page 33, the Lewis and Kossel models are depicted side by side, the former being cubic and the latter an arrangement of the electrons in one plane, the outer number in these examples being 8, the octets being completed ones. On the same page Lewis says:—'' In this connection I emphasised the peculiarity of hydrogen which, by giving off an electron, can become the simplest *of positive ions, consisting solely of an* atomic nucleus, while by taking on one electron it can complete the group of two, characteristic of the helium atom. This process seemed so nearly like the taking on of one electron by fluorine or by chlorine to form F^- or Cl^-, with structures corresponding to neon and argon, that I felt justified in regarding hydrogen as belonging, in this respect at least, to the halogens; and therefore predicted that metallic hydrides would prove to have the character of salts, consisting of metal ion and hydride ion, and further that electrolysis of a hydride should produce hydrogen at the anode. This prediction has been entirely verified in the work of Bardwell (1922), who succeeded in electrolysing a melt containing calcium hydride, and obtaining hydrogen at the anode in amount corresponding to Faraday's law.''

In Chapter III. the spectral lines are well illustrated and the ''physicist's view of the atom'' given. The Lyman, Balmer, Paschen and Brackett series formulæ are stated on page 38, together with diagrams illustrating the principal lines and the ''basic frequencies of hydrogen.'' The quantum theory is dealt with at some length, and the energy levels in the H atom diagrammetrically given on p. 43. X-ray spectra, ionisation, and resonance potentials are treated briefly.

origin On page 50 the following appears:—'' It portio. predicted from the classical electro- mains co. theory that any accelerated charge increases. radiant energy, but the electron able, allowing in one of the stable orbits of the Bohr theory is subject to constant acceleration toward the centre of the atom, and yet it is supposed to emit no radiation. However such emission of energy from an accelerated charge does not seem to be an entirely inevitable consequence, even of classical theory, and for this reason we may turn our attention to a still more elementary way in which I have attempted to show (1917) the divergence between the properties of the Bohr atom and the properties that would formerly have been assumed for a system containing an electron in motion.'' The argument that follows here is interesting and should be studied in the original.

On page 58 Lewis records that '' in a recent investigation of extraordinary interest, Stern and Gerlach (1921) have succeeded in studying in a most direct manner the magnetic properties of the silver atom, which, like the hydrogen atom, we suppose to have one electron in its outer shell. They find *that its behaviour is similar to that which* would be predicted for the hydrogen atom by the Bohr theory.'' Further, on page 66, we find the following:—'' In the meantime it must be admitted that the problem is by no means completely solved. Both Bohr and Bury assume that the last fragmentary period of the Mendeléeff table is a period of thirty-two elements; but I have pointed out in a previous chapter that the properties of thorium and uranium indicate a far less resemblance to the preceding period of thirty-two than to the next preceding period of eighteen.'' We may remark here that Loring's wedge table accords with Lewis in this respect.

Of particular interest, the part from Chapter V. onwards may be noted. Here we find discussions of the union of atoms the chemical bond, pairing of electrons double and triple bond, limitation of multiple bonds, exceptions to the rule of eight valence and co-ordination number, quadrivalence of nitrogen, valencies higher than four, valence and condensed systems, compounds of elements with small kernels, elements in positive and negative states electromers, &c.

Finally, we may quote from page 142, as follows:—'' We are inclined to think of substances as possessing acid or basic properties, without having a particular solvent in mind. It seems to me that with complete generality we may say that *a basic substance is one which has a lone pair of electrons which may be used to complete*

the stable group of another atom, and that *an acid substance is one which can employ a lone pair from another molecule* in completing the stable group of one of its own atoms. In other words, the basic substance furnishes a pair of electrons for a chemical bond; the acid substance accepts such a pair." Prof. Lewis (page 148) regards the *pairing* of electrons "as the most fundamental phenomenon in all chemistry."

A list of references is given at the conclusion of the book. The book is indexed (but this might be slightly improved—a statement which applies to most books), and the printing and binding is, of course, up to the best standard.

Kolloide in der Technik, von DR. R. E. LIESEGANG. Pp. 157. Dresden & Leipzig. Verlag von Theodor Steinkopff. 1923. Price 3s. 6d.

The importance of a thorough knowledge of the principal phenomena exhibited by substances in the colloidal condition is now becoming recognised by technologists.

Prof. Liesegang has presented, in this volume, a very interesting account of the application of these principles to various technical and industrial processes. He gives a very good resumé of the recent theoretical and practical advances that have been made.

From a description of the behaviour of bodies in the colloidal state as exemplified by gelatin and similar bodies, and the protective colloids, he passes to their connection with such processes as that of tanning and those, for instance, of the textile indus-industries.

Soaps, oils, resins, rubber, the metals, ceramics and foodstuffs are all discussed from the point of view of colloids.

The final chapter on Photography has been very ably written, and contains an excellent account of the latest work and theories in all the processes encountered in this field.

The references to British and American workers and their researches are surprisingly good when it is remembered that German scientists encounter great difficulties in obtaining inormation concerning scientific work carried on outside their country.

Uses of Waste Materials, by PROF. ARTURO BRUTTINI. Pp. XX. + 367. 1923. Messrs. P. S. King & Son, Ltd., Orchard House, 2 & 4, Great Smith Street, Westminster. 12s. net.

The author has collected much useful information on the utilisation of waste materials during the years 1914-22, for making human and animal foods, and for agricultural fertilisers.

For many of these products, it may be noted that no essentially new process was involved, but instances are given where new and often ingenious methods were adopted.

Attention is drawn to the importance of profiting by these experiences. Processes of proved economic value should be retained and developed in the future. It will be realised that many of the substitutes manufactured during the war in the belligerent nations were of no permanent importance, since they were introduced to meet exceptional and temporary needs.

In Part I. the author gives the legislative measures adopted for the utilisation of waste products as foods, etc.

Part II. contains a detailed account of the collection and treatment of various types of waste. The limits to which Germany was driven by the war in her efforts to provide substitutes for almost every item of food are fully realised by a perusal of Prof. Bruttini's compilation. Yeast, blood, potatoes, straw, meal, etc., were all used in eking out flour in bread-making. Various plant products were employed for making something to resemble coffee, and a valuable list of wild plants fit for human consumption is given. The substitutes for meat and table oils in the Central Empires were naturally far removed from the articles they were intended to replace.

Great ingenuity was displayed by agriculturists in all countries during the period under review, in opening up new sources of fodder. Matter of more permanent value is, however, to be found in the section on fertilisers. Residues from many industries could well be utilised as fertilisers to a far greater extent than is at present realised. Undoubtedly a more scientific and intensive use of waste can be achieved, involving a saving of much wealth at present lost. This monograph very clearly shows the lines on which the problem should be attacked.

A number of misprints have crept into this excellent work. These should be corrected in future editions, which may be confidently expected.

Industrial Filtration, by ARTHUR WRIGHT, M.E. Pp. X. + 336. Vol. I., 1923. The Chemical Catalog Co. Inc., 19, East 24th Street, New York, U.S.A. $5.00.

These are so few books on specific indus-

trial processes, and it is noteworthy that this is the first of a new series, each volume of which is to be devoted to one particular process. Among those to follow are volumes on *Heat Transfer and Evaporation; Theory and Practice of Evaporation;* and *Fractional Distillation.*

The present volume is divided into three parts. In the first part, the author discusses such matters as clarification, cake building, washing, drying, and discharging; filter media, and auxiliary equipment. This section is entitled *Theory of Filtration*, which is somewhat misleading to an English reader (this is an American publication).

Part two, the *Mechanics of Filtration*, gives a useful account of certain types of filters and presses now used, although there is no mention of centrifugal apparatus.

Part three is concerned with the applications of the various types of plants described, and the general works practice.

The author's aim has been to emphasise the importance of the fundamental principles, and to discuss the merits of certain types of American machines. This latter has unfortunately given the book somewhat the aspect of a commercial catalogue.

The book will be helpful to many technical chemists who have filtration problems to contend with.

The Department of Overseas Trade has published (through H.M. Stationery Office) a *Report on the Economic Conditions in South Africa*, by Mr. W. G. Wickham, H.M. Senior Trade Commissioner in South Africa; July, 1923, price 1s. 6d. net.

Among industrial raw materials, soda ash, caustic soda and potash show considerably increaesd importation at lower price levels. On the other hand, in spite of the lower price, we find actually a reduction in the quantity imported of nitrates, glycerine, sulphur, and cyanides. The dislocation in gold mining and cessation of diamond mining are no doubt responsibe ldirectly and indirectly by reducing the demand for the locally manufactured explosives.

Paraffin wax shows an importation doubled in quantity, but at a much reduced price. Vegetable and mineral oils are also lower in price, but demand has not fully responded to this stimulus.

BOOKS RECEIVED.

The Life of Sir William Crookes, .M., F.R.S., by E. E. Fournier, D.Albe., D.Sc., F.Inst.P., with a foreword by Sir Oliver Lodge. Pp. XVII. + 409. 1923. Messrs. T. Fisher Unwin, Ltd., Adelphi Terrace, W.C.2. 25s. net.

The British Journal Photographic Almanac for 1924, Edited by George E. Brown, F.I.C. Pp. 812. Henry Greenwood & Co., 24, Wellington Street, Strand, W.C.2. Paper, 2s. net.; cloth, 3s. net.

Molekulargrössen von Elektrolyten, von Dr. Phil. Et Chem. Paul Walden. Pp. XI. + 350. 1923. Verlag von Theodor Steinkopff, Residenzstr. 12b, Dresden und Leipzig. 11s. 6d.

The Principal of Relativity, by Albert Einstein, H. A. Lorentz, H. Minkowski, A. Sommerfeld, H. Weyl; Translated by G. B Jeffery, D.Sc., and W. Perrett, Ph.D. Pp. VIII. + 216. 1923. Messrs. Methuen & Co., Ltd., 36, Essex St., W.C.2. 12s. 6d. net.

New Patents.

This list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

30305—Bredig, G.—Production of cyanide compounds. Dec. 1.

Abstract Published this Week.

205288—Nitrogen oxides.—Goodwin, C. J., of 7, Idol Lane, London.

In the production of nitrogen oxides by exploding a mixture of combustible gas and air of oxygen in a bomb or engine, the combustible gas, such as coke oven gas, coal gas, water-gas, or producer gas, is treated to increase its nett calorific value by removing some or all of its free hydrogen.

The invention is described with particular reference to coke oven gas, and the hydrogen alone, or the hydrogen and carbonic acid are removed. The removal of the hydrogen may be effected in any suitable manner, either physical, such as liquefaction or low-temperature separation, or chemical, as by adding carbon monoxide and using the mixture to synthesise methyl or ethyl alcohol under pressure by catalytic or other means, the remaining gas in this last case being mainly methane. When the hydrogen is removed as such it may be converted into ammonia by the known synthesis.

Messrs. Rayner & Co. will obtain printed copies of the published specifications and abstract only, and forward on post free for the price of 1s. 6d. each.

Mr. Edward C. Davies, M.Sc., a distinguished student of Prof. Robert M. Wild at Manchester University, has been appointed as Assistant Lecturer in Chemistry at the Natal Technical College, Durban, S. Africa.

THE CHEMICAL NEWS,

VOL. CXXVII. No. 3324.

' HYDROXY 1 PHENYL 5 METHYL-BENZOTHIAZOLE AND ITS BROMINATION.

BY R. F. HUNTER.

If the considerations which have already en put forward by the author as to the ructure of the dibromination products of hydrothiotoluidin and its derivatives are rrect, then, since the phenollic derivative this benzothiazole contains the usual iazole ring containing the double bonded trogen and carbon atoms, the 4′ hydroxy phenyl 5 methylbenzothiazole should add omine according to the equation:—

$$H_3C_6H_3 < {}^{S}_{N} \gtrless CC_6H_4OH + 2Br =$$

$$CH_3C_6H_3 < {}^{S}_{NBr} > CBr\ C_6H_4OH,$$

hen dissolved in glacial acetic acid. A oint, however, arises, and that is whether e presence of the hydroxyl group in the nzene part of the molecule might not oduce a tendency towards substitution in dition to the bromine addition to the thiale ring. If such a tendency does exist, en clearly we should expect that a precipitate would be formed when bromine is dded to the aqueous solution of the phenol a manner analogous to the precipitation trihromophenol from aqueous solutions means of bromine water. The 4′ hyoxy 1 phenyl 5 methyl benzothiazole was erefore prepared and examined by the ethod given in the experimental portion of is paper. Addition of bromine to a soluon of the compound in glacial acetic acid oduced the expected precipitate of the sual type. Addition of bromine water to aqueous solution of the compound aparently had no action. This evidence nnot be considered of very great imporance, since the solubility of the phenol of hydrothiotoluidin is very low. On the her hand addition of bromine water to an cohlic solution of the compound proced a grey flocculent precipitate, which ite possibly was unchanged, the base settling out owing to the diminished solubility in the solvent. The quantity was, of course, too small for investigation.

EXPERIMENTAL.

1.5 gm. of pure dehydrothiotoluidin from alcohol is dissolved in the minimum of fairly strong sulphuric acid in a 250 cc. flask. The solution is cooled under the tap. 0.5 gm. of sodium nitrite dissolved in 3 ccs. of water is then added to the cooled solution. The resulting solution is then heated on a boiling water bath till the evolution of nitrogen ceases, a red brown tarry solid remaining, which floats on the surface of a similarly coloured liquid. It was wrongly thought that the compound might be volatile in steam, so that the flask and its contents were therefore steam distilled for three hours, and the distillate searched for a substance with phenolic properties in vain. The solid remained quite unaffected in the flask during the distillation. The acid present was neutralised with strong caustic soda solution. Further addition caused sudden and nearly complete solution as a deep brown liquid. This was filtered from a small black residue to a deep brown clear liquid, to which hydrochloric acid was added drop by drop, with the immediate formation of a yellow brown precipitate. The addition of acid was continued until nothing more was precipitated. The liquid was then filtered, and the precipitate washed and dried. The phenol remained on the filter paper as a pale brown solid.

A portion was dissolved in glacial acetic acid, and bromine was added drop by drop from a burette. A brown precipitate formed at once. The precipitation was completed by drowning with cold water, after allowing the beaker containing the bromination product and excess bromine to stand for a few minutes.

A small amount of the phenol was dissolved as completely as possible in hot water, the solution filtered, and bromine water added to the filtrate. There was no precipitate.

A small amount of the substance was dissolved in alcohol in the same way, and bromine water was added. A grey flocculent precipitate resulted.

The Imperial College of Science and Technology, S.W.7.

September. 1923.

"DRY-ROT" DISEASE OF TIMBER.

By E. H. Ellis.

Amongst other non-chemical problems upon which industrial chemists are required to give advice, the control of "dry-rot" of timber is one of annoying persistence.

"Dry-rot" is caused principally by the fungus *Merulius lacrymans*. It is a disease of civilisation. Indeed, quite apart from the fact that the actual dry-rot fungus grows only upon worked wood and is rarely, if ever found on living trees, the term "dry-rot" has been restricted by architects and timber-merchants to the rot of worked wood; many fungus diseases produced in the standing timber being known *collectively* as "*wet-rot.*"

Infection of wood often occurs during storage in a timber yard. The spores of dry-rot, although capable of remaining viable for a period of years, apparently infect sound wood with difficulty. Hence infection is rarely caused by the spores, being commonly due to the spread of the mycelium. Also, during periods of drought, the protoplasmic contents of the mycelium become agglomerated, the cell-walls break up into small resting bodies (oidia), which are easily scattered, and which germinate readily, causing re-infection.

In spite of its name, the "dry-rot" fungus, like all fungi, must have moisture to enable it to grow; the term "dry-rot" referring rather to the condition of wood attacked by the fungus than to the fungus itself.

When a piece of constructional timber is attacked by dry-rot, two distinct types of growth may be seen. The first consists of a fine network actually inside the wood, which supplies the proteins essential to fungus growth. The threads composing the network secrete various enzymes as hadromase, cytase and emulsin, by which the coniferin (constructional timber is usually coniferous), and cellulose of the cell-walls are dissolved, and a residue of lignin, tannin and calcium oxalate is left behind. So long as sufficient moisture is present the wood retains its original volume, but with the gradual withdrawal of water numerous right-angled cracks appear. Under certain conditions of moisture a skin-like growth or balled pads of the fungus may invest a timber balk. Sometimes, principally through either a lack of food material or moisture, the filaments of the fungus grow together, forming white cords, which later become a slaty-grey colour and may become about a quarter of an inch thick. The cords have a characteristic structure, and examination with a microscope reveals three kinds of threads that can be distinguished according to their size and the thickness of their cell-walls. There are thin-walled threads of normal width; long and wide, water-conducting-threads; and fibrous threads, whose thickened walls serve for mechanical support. The whole fungus may glisten with drops of extruded water, possibly for ultimate conduction to the point of attack upon the drier parts of the wood. These tear-drops are not conducted from the source of water-supply, but are formed by the respiration of the fungus. The principle involved is mainly one of oxidation of the host wood. Oxygen from the air is essential for respiration. Adopting an empirical formula for wood, the dry-rot fungus has been shown to be able to produce water to about half the weight of the original wood.

$$\underset{\substack{(1018)\\(\text{Wood})}}{C_{42}H_{66}O_{28}} + 89\,O = \underset{(594)}{33H_2O} + 42CO_2$$

Thus the dry-rot fungus can actually produce the moisture necessary for its own existence. The formation of oidia, or the variously coloured fruit bodies, is more or less an indication of local failure of water supply or food material. The superficial growth can also be related to local shortage of water supply, and by means of it the fungus can spread over such unpromising material as brickwork and tiles, and can penetrate mortar and thus attack distant wood.

"Dry-rot" has been the reputed cause of various human diseases, but this is impossible, as blood heat is fatal to the fungus.

In questions of control a distinction must be drawn between prevention of infection, and dealing with existing infection. In the first case, contact with infectious material must be guarded against, only well-seasoned wood should be selected, and sawn wood should be stored in the dry and be well ventilated. Buildings in which the timber is afterwards used should also be well ventilated.

Timber can be treated with antiseptics, but this method is very costly, as for perfect success the wood must be impregnated. Copper sulphate, iron sulphate, zinc chloride and mercuric chloride have been recom-

mended, but are impracticable. Sodium fluoride, boric acid, and above all, magnesium silicofluoride, have been found to be the best inorganic preservatives. Amongst organic preservatives creosote and tar, but their colour and smell restrict their use.

Dinitrophenates and dinitrocresates of potassium and sodium are effective, particularly the sodium salt of dinitrophenol, which, however, is decomposed by light, and, being explosive, must be mixed with an inert substance. Kiln drying of wood has also been recommended.

When dealing with an existing attack of "dry-rot," infected wood must be removed, surrounding woodwork examined, and exposed surfaces disinfected. Walls and woodwork may be washed with formalin, and finally coated with an antiseptic. Care should be taken to obviate future damp.

[*An excellent critical account of "dry-rot" and also of many other fungus diseases of timber may be found in the "Handbook of the Larger British Fungi," by Mr. J. Ramsbottom, the well-known authority on these matters, recently published by the British Museum (Natural History).*]

WHAT IS A CHEMICAL?*

By J. N. Taylor, M.S.[1]

There has recently come about a most interesting discussion regarding the definition of a synthetic organic chemical. According to *Chemical Age* (New York) for April, 1923, the Board of Governors of the Synthetic Organic Chemical Manufacturers' Association has adopted the following definition: "Synthetic Organic Chemical—An organic chemical which has been produced by a controlled process involving change in chemical identity." A "chemical" is defined as "a material containing a preponderating proportion of an individual substance of definite elementary composition." Attention was called to these definitions in an editorial appearing in *Chemistry and Industry* for May 18, 1923, and further reference was made to the definition of "synthetic organic chemical" by Mr. E. Parry in giving testimony at the hearing (June 15, 1923), on "Formaldehyde," under the Safeguarding of Industries Act (England), as to whether or not formaldehyde is a *synthetic organic chemical.* He observed[2] "that the difficulties of definition had become so great in the United States that only this month the Synthetic Organic Chemical Manufacturers' Association of the United States had attempted to define a synthetic organic chemical, but the definition arrived at was meaningless."

The subject of chemical nomenclature is one of general interest, engaging the attention of educators in the science as well as the various chemical societies and other associations having for their object the advancement of science. Some time ago the present writer took occasion to direct attention to the desirability of greater uniformity in chemical terminology,[3] especially in our schools and colleges. A number of welcome and helpful criticisms of the paper were received pointing out that the English language is a growing one, that it is yet in process of evolution, and that growth and change in our language demand simpler and more concise forms for conveying chemical ideas. This is indeed true. In any live, growing language, words change in meaning in the course of time. Couch, in his admirable series of articles now appearing in the *American Journal of Pharmacy*, entitled "The Evolution of Chemical Terminology," traces this very interesting development of our science. Divergences in the connotation of a word or term, recognisably depend in great measure upon the aspect which the word or term assumes. Such terms as "chemical" and "synthetic organic chemical," for example, might each convey different meanings from the point of view of a manufacturer, a dealer, a teacher, or an analyst, or when viewed from the standpoint of the tariff or the census, or when thought of as entering into interstate commerce.

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* *Reprinted from "The American Journal of Pharmacy," Philadelphia., Pa., October, 1923.*

[1] ***Instructor in Chemistry at the Washington Preparatory School and at George Washington University.***

[2] *"Chemistry and Industry."* (*Jour. Soc. Chem. Ind.*) Vol. XLII., No. 26, p. 643.

[3] *Taylor, J. Norman: "Chemical Nomenclature and Pronunciation," School Science and Mathematics, Chicago,* Vol. XX., No. 9 (1920). ***Reprinted in Jour. American Pharm. Assoc., Philadelphia,*** Vol. X., 10-11 (1921), ***and in Chem. News, London,*** Vol. CXXII., 7 (1921).

Certain words, when used in a legal sense, are specifically defined, and the extent to which an adjective may partake of the attributes of the noun are, therefore, *limited by definition. Certain Acts of Congress* specify for the purposes of the Acts the limits in meanings of certain words. For example, the Food and Drugs Act, June 30, 1906, defines the term "drug" as used in the Act as "all medicines and preparations recognised in the U.S. Pharmacopœa or National Formulary for internal or external use, and any substance or mixture of substances intended to be used for the cure, mitigation or prevention of disease of *either man or other animal*." The noun "drug" and terms derived from it are, therefore, circumscribed in meaning when employed under the provisions of the Act. As anothe rexample may be mentioned the word "insecticide." The Insecticide Act of 1910 defines "insecticide" as follows:—"The term 'insecticide' as used in this Act shall *include any substance or mixture* of substances intended to be used for preventing, destroying, repelling or mitigating any *insects which may infest vegetation, man* or any animals or households, or be present in any environment whatsoever." Naturally, the adjective "insecticidal" is limited in meaning for the purpose of the Insecticide Act, because of the meaning given the word "insecticide" by the framers of the Act. On the other hand, the *popular* meaning of words such as are noted above may extend beyond the limitations set down for them *ex cathedra*.

As an *adjective*, there appears to exist little, if any, confusion regarding the use of the term "chemical." We are accustomed to speak of "chemical reactions," "chemical compounds," "chemical products," etc., and, *through custom* and usage, their meanings carry no ambiguity. To what extent, however, may the popular concept of the meaning of the adjective be applied to the noun? When an attempt is made to distinguish between "chemical" and "chemical compound," between "chemical" and "drug," or between a chemical and the result of a chemical process, there appears to be a misunderstanding as to just what is conveyed when the word, "chemical," is employed as a noun.

It would seem apropos, therefore, in view of the present discussion of the meaning of the noun "chemical," to reaffirm the province of chemistry, hoping thereby to establish a position from which we can survey this question in the light of both theory and practice.

Chemistry investigates the composition and properties of substances and the changes which they undergo. It deals with the energy changes within and between or among molecules and atoms of substances. Hence, in its application, it includes all material things which are the result of energy *transformations*. To the chemist, therefore—and who should be better qualified to speak on chemical topics than the chemist?—all substances which enter into and result from such energy transformations are chemicals.

There is nothing original in this statement, however. Munroe,[4] as long ago as 1905, in his monograph, "Chemicals and Allied Products," in discussing the classification of materials coming within the scope of the investigation for the Bureau of the Census, declared that, "*in the strictest technical sense every material thing is a chemical.*"

Obviously, until some such fundamental definition of a chemical is agreed upon and the start is made from this base, the efforts *to obtain divisional definitions that will* be generally accepted will be unavailing. With this in mind the foregoing definition is presented for consderaton.

THE SITUATION IN THE COAL INDUSTRY.

ATTITUDE OF THE COLLIERY OWNERS.

In view of the unauthorised and contradictory statements that have appeared in the press with reference to the meeting on December 13 of the sub-committee appointed to review the Wages Agreement in the coal mining industry, the Mining Association is of opinion that an authoritative announcement should be made with reference to the attitude taken up by the representatives of the owners on that committee.

It will be remembered that the demands put forward by the Miners' Federation were as follows:—

[4] *Munroe, Charles E.*: "*Chemcals and Allied Products,*" *Census of Manufactures*: 1905, *Bulletin* 92, *Bureau of the Census, Department of Commerce and Labour, Government Printing Office, Washington,* 1908.

1.—That the ratio of profits to wages should be altered from 17 to 100 below the standard and 17 to 83 above the standard to a constant ratio of 13 to 100 both above and below.

2. That the minimum wage should be raised from 20 per cent. to 40 per cent. agove the standard.

3.—That further information should be accorded to the miners on costs other than wages.

In the course of the discussions on Thursday last, it was stated by Mr. Evan Williams on behalf of the owners that on certain points the members of the sub-committee had an ope nmind, and would be prepared to recommend to the members of the Mining Association certain alterations in the Wages Agreement which would operate to the advantage of the men, provided that certain concessions were made by the Miners' Federation in regard to clauses that inflicted undue hardship upon the owners in the less prosperous districts.

As regards the first claim, for the alteration in the ratio between profits and wages, the owners' representatives on the sub-committee were prepared to consider putting forward a recommendation that the ratio should be constant both above and below the standard, and that the proportion allotted to profits should be something less tha n17. No precise figure was mentioned, but it was indicated that it would have to be considerably higher than the 13 demanded by the Federation.

As regards the second demand, the owners found themselves unable to make any concession, and it was pointed out by Mr. Evan Williams that the proposed alteration in the minimum from 20 per cent. to 40 per cent. above the standard would not ameliorate the position of the lower paid men, on whose behalf the miners' leaders were putting forward the demand, since these men were already protected by the subsistence wage. For instance, in South Wales the standard wage for surface labourers is 5s. 3.9d. per shift, and the minimum wage therefore is 6s. 4.8d. If the minimum were raised to 40 per cent. above standard, the figure would be 7s. 5.5d., whereas under the subsistence wage it is actually 7s. 8d.

The suggestion was, however, put forward by Mr. Evan Williams that the lot of the lower paid men might be sensibly improved by a redistribution of wages as between them and the higher paid piece workers. He instanced the 14.2 per cent. advance which was awarded to the piece workers to make up for loss of earnings consequent upon a reduction of the hours from 8 to 7, and suggested that this might be more equitably allocated to the lower paid men.

As a result of this advance of 14.2 per cent., the earnings of the piece workers showed a greater relative increase over their pre-war earnings than did those of the lower paid men, whose need was actually the greater. For the whole of the United Kingdom, except Northumberland and Durham, which were unaffected by the alteration in hours, the percentage increase for the higher paid piece workers was 73, as against 59 for the lower paid men.

As regards costs other than wages, Mr. Evan Williams emphasised that the items for which the miners were asking for further information were such as could not be influenced in any way by them (the miners). At the same time, he said, the representatives of the owners had been favourably considering this demand, and were prepared to recommend that a considerable volume of further information should be given.

The principal conter proposal put forward by the representatives of the owners was in connection with the recoupment of standard profits sacrificed in order to pay the minimum wage which, under the award of the independent chairman, are practically irrecoverable out of any future surplus. The representatives of the miners were reminded that this was not the intention of those who originally drafted the Agreement, and it was indicated that the owners would certainly require the revision of this restrictive interpretation as a *quid pro quo* for any concession that they might be prepared to make. At the same time they realised that to recover out of any immediately ensuing surplus an accumulated deficit might impose considerable hardship on the miners, and they would therefore be prepared to consider proposals for spreading such recoupment over a period occupied by several ascertainments.

In conclusion, the Mining Association wishes to emphasise the point that members of the sub-committee, in putting forward the above-mentioned suggestions for further discussion, were animated by the sincere conviction that the termination of the Wages Agreement at the present time would be a national disaster. It is realised that this Agreement is a far from perfect instrament, but at the same time it is held to be the greatest step forward yet made in

the history of British industry towards settling differences and apportioning the *proceeds of an industry between labour,* capital, and management. It was these considerations, and not any conviction that the agreement had hitherto operated too much to the advantage of the owners—who indeed have received far less under it than they were entitled to expect—that led the representatives of the owners to make this further attempt to secure for the coal mining industry that peace which is so essential to national recovery.

It is upon the ability of the industry to pa ythat the owners take their stan.d The *demand for an increase in the minimum to* 40 per cent. above the standard destroys *the whole spirit of the Wages Agreement.* which was based fundamentally upon the conception that the industry must henceforward be self-supporting and must pay its own way. If the demand were conceded, the wages in the poorer districts would no longer rest upon the ability to pay, and this would render impossible any form of national agreement. Any artificial increase in the price of coal would be merely an effort to bolster up an uneconomic situation, and woul dbreak down in practice after having caused a great increase in the volume of *unemployment.*

It was pointed out to the representatives *of the miners that in the poorer districts* the rate of output showed a greater reduction per person employed than in the more prosperous areas. The solution of the problems facing the coal industry can only be found gy an increase in output per person, and it is extremely doubtful whether such increase can be achieved, at any rate in the poorer districts, under the present restrictions—embodied in an Act of Parliament—on the number of hours worked underground.

FEDERATION OF BRITISH INDUSTRIES.

(Incorporated by Royal Charter.)

Report of the Committee on Central and Local Taxation.

The Committee was appointed by the Executive Committee in February, 1923, with wide terms of reference, to consider the whole question of central and local *taxation and administration, particularly in regard to the desirability of decentralisation of control and of greater industrial representation on local authortiies.* The following Report of the Committee was adopted by the Executive Committee of the Federation on December 12, 1923:—

Burden of Taxation upon Industry.

The Committee feel that there is no need for them to dwell upon the burden which is being borne by industry in the form of taxation at the present time. Of the huge amount levied annually for the national exchequer, by far the largest portion is derived in one form or another from industrial sources. To this burden must be added the further contribution which has to be made by industry in the form of rates. The growth of municipal expenditure in the course of the last twenty years has been extraordinary, and although the most recently published figures show that some reduction is now beginning to be effected, the total still remains at a very high figure.

A further fact which intensifies the burden is the unfair inclusion of machinery for rating purposes. This accentuates the *inequalities as between industrialists* and other ratepayers. The Committee *understand that the Government has appointed* a Committee to investigate this question, and the publication of a Draft Rating and Valuation Bill is evidence that the whole *question of assessments is receiving* consideration. The Committee consider that legislation on the question of machinery rating in England is urgently required, and strongly recommend that the Federation should carefully examine the question by means of an expert Committee, with a view *to giving evidence before the Departmental* Committee.

Increase in Rates Since 1913.

The Committee have recently made enquiries from firms in a great variety of industries and scattered throughout the country, with a view to comparing the amounts paid by such firms to local rates in 1913 and 1922. The result of their enquiry shows that the payments to rates increased on an average no less than 295 per cent. in the *period mentioned, in spite of the fact that* contributions to health and unemployment insurance, which might have been expected to reduce the contribution to poor relief, have actually increased 328 per cent. Making all allowances for the difference in conditions between the two years mentioned, and in certain cases the increase in assess-

ments due to extensions of works, the Committee still feel that so large an increase is unjustifiable. When these percentage increases are compared with the increase in the cost of living, which, according to the index figures, rose from 100 in 1914 to an average of 181.5 in 1922, or the increase in the index of wholesale commodity prices from 100 in 1923 to an average of 159 in 1922, it is clear that *prima facie* evidence of the necessity for an enquiry into the whole system is afforded.

INCREASED COST OF LOCAL GOVERNMENT SINCE 1913.

The Committee are aware that the cost of local government must be higher at the present time than before the war. The increased cost of living is reflected in higher wages and greater cost of materials, while the trade depression has been responsible for a large increase in the cost of relieving distress. Many expenses which normally would have been carried out during the war years have been postponed, and, in addition, new services have been imposed upon local authorities as the result of legislation passed since 1913. Tuberculosis, venereal diseases, maternity and child welfare, and mental deficiency services have all been added to the duties of local authorities since that date. There are also increased charges in connection with housing and with the registration of electors under the Representation of the People Act.

The Committee do not wish for a moment to suggest that the objects of this expenditure are not from a social point of view eminently desirable. They believe, however, that largely owing to the unsatisfactory demarcation of functions between the central and local authorities, the administration has not been upon the most economical basis, and that the results obtained have hardly been commensurate with the expenditure involved.

LOCAL EXPENDITURE AND CENTRAL CONTROL.

Many of these services are financed partly by contributions from State Funds, and the Central Government Department dictates to the local authority the expenditure which must be incurred. In all cases, although the administration is carried out locally, a greater or lesser degree of control is retained in the hands of the Central Government Department. The Committee are convinced that this must inevitbaly, and in practice does, result in overlapping and extravagance of administration. This arises not merely from the duplication of inspection, which takes place notably in connection with the administration of the Education Acts, but also from the fact that Parliament and the Treasury are less well placed to exercise detailed control over the minutiæ of local erpenditure than the local ratepayers, to whom the members of the administrative committees are directly responsible.

RELIEF OF DISTRESS.

A very striking example where there is probably overlapping in expenditure as well as in administration is afforded by the payments for relief of distress and unemployment. It is particularly unfortunate that these result in swollen rates at a time when industry is least able to bear an additional burden. The effect of this was shown in 1922 in the case of one distressed area where the poor rate per ton of steel manufactured (comparing the output for the respective years) had increased no less than 2,396 per cent. since before the war, an increase in the cost of production which, of itself, would have no small effect in restricting the flow of orders and thus indirectly causing unemployment.

While it is difficult to form any estimate of the extent to which there is overlapping of relief from the different sources, the Committee would call attention to the lack of co-ordination at present existing in the administration. Unemployment payments, poor law relief,* feeding of school children, are all directed towards the assistance of the same class of beneficiaries, and the fact that the administration of these services has not been co-ordinated cannot fail to have resulted in extravagance. This matter was dealt with at some length in the report which was presented to the Grand Council a year ago by the Unemployment Insurance Committee.

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* *NOTE.—A further point with regard to poor relief is that in recent years the Ministry of Health has given permission to Boards of Guardians to raise short-term loans from private lenders, amounting in some cases to very large sums. While it may have been inevitable that extraordinary additional sums should be raised for the relief of distress, it is, in the opinion of the Committee, most undesirable that the money should be raised in this way to meet current expenditure, and that borrowing powers of this nature should be conferred upon Boards of Guardians.*

The Committee would call attention to the valuable suggestions which have been made on this subject by the Denison House Committee on Public Assistance. That Committee has advocated the publication of a complete and up-to-date annual return of all expenditure from rates and taxes on direct public assistance, with details as to administrative cost, and, further, of a register of beneficiaries, which they maintain must be the basis of all reform. The Committee strongly commend these proposals, and further support the adoption of the Denison House Committee's recommendation of an annual estimate of future public expenditure on direct public assistance, as soon as general conditions become sufficiently normal to make this practicable. The Committee are convinced of the economies which can be effected by a greater co-ordination of public assistance.

NEED FOR RECONSIDERATION OF DUTIES OF LOCAL AUTHORITIES.

In view of what is said above, the Committee feel that the time has come to reconsider the duties of local authorities and the scope of the functions which should be delegated to them. Not only should the Central Government take as much advantage as possible of local patriotism and local talent; it should also allow greater autonomy in administration to local authorities within the zone of approved expenditure, and although the need will remain for financial assistance to be afforded by the national exchequer, this, when approved, should not be accompanied by the detailed control at present exercised by the Central Departments. The Committee agree that some safeguards will be necessary, and they would suggest for consideration that where, after a public enquiry held by the Ministry of Health, it is shown that a local administration has been guilty of extravagance and abuse of the powers vested in it, the Ministry of Health should be empowered to suspend the local authority concerned, and to appoint directly stipendiary administrators to carry out its duties.

"ONEROUS" AND "BENEFICIAL" SERVICES.

The Committee wish to qualify their suggestions for a reconsideration of the functions of local authorities by referring to the distinction which has been drawn by the Royal Commission on Local Government in 1896 and the Departmental Committee, which reported in 1914, between "onerous" and "beneficial" services. "Onerous" services are defined as those which a local authority is called upon to perform for the benefit of a greater area than its own locality, while "beneficial" services are those which confer a merely local advantage. They consider that this distinction should be kept in mind, although conditions have changed so much since the Report of the Departmental Committee was issued that the conclusions now reached would probably differ in some respects from those of that Committee.

NEED FOR COMMITTEE OR COMMISSION ON INCIDENCE OF TAXATION.

Before, however, any final recommendations can be made on this subject, a strong Committee or Commission should be appointed to examine the incidence of taxation. At the present time the exact incidence of contributions to national or municipal exchequers is to a great extent a matter of guesswork, though both classes of taxation undoubtedly add to the cost of production. The Committee feel that it is a matter of the greatest importance that an enquiry into this subject shoul dhe initiated without delay.

The Committee have already called attention to the Draft Rating and Valuation Bill which is now receiving the attention of authorities interested throughout the country. They understand that detailed recommendations in regard to this Bill are being considered by the Taxation Committee of the Federation, and they therefore do not propose to go into its provisions. They regret, however, that the Government have decided to bring forward this Bill before they have initiated an enquiry into the incidence of taxation. For the same reason they are not satisfied that the investigations at present being carried out by a Royal Commission into the question of the areas of local government and by a Departmental Committee into the percentage grant system can adequately meet the difficulties of the situation, and while they do not doubt that both these enquiries will result in useful information being obtained, they feel that the problem has more fundamental aspects than can be dealt with under the terms of reference of either body. For these reasons they recommend that a Committee or Commission should be appointed, with the terms of reference which they have indicated.

TRADING SERVICES.

Before concluding their Report, the Committee desire to record that they are not able to suggest any fresh resources which

can be drawn upon to meet local expenditure. In more prosperous times the trading services, carried out by municipalities could be ranked as assets, since their operations resulted in profits which went to relieve the rates. Now, however, this position has been reversed, and these services are in many cases a definite liability leading to substantial increases in already heavy rates. Thus, in the case of one local authority, whose budget they have had an opportunity of considering, the Committee note that for the year 1913-14 trading services showed a credit balance of £91,600. In the year 1922-23 this has been converted into a debit balance of £118,323. This new situation requires a complete review of the principle of municipal trading services. The Committee are convinced that the principle should be generally adopted that trading services must be self-supporting, and, if not, should be discontinued in favour of private enterprise. By this they do not mean that each year's working must show a profit, but they consider that if over a period of years a trading service shows a loss, power should be taken to close down that particular trading activity, and thus relieve the rates from the necessity of subsidising it. Moreover, the Committee consider it wrong in principle that profit should be the primary object for which municipal enterprises are instituted. Such enterprises should be judged entirely on the ground of public policy involving such questions as the anticipated service to the community, the dangerous effect of political pressure on costs and charges, and the probable influence upon the competitive and other industries. As to other possible bases of taxation besides that which at present supports the rating system, the Committee find themselves in agreement with the Royal Commission on Local Government and the Departmental Committee that no suitable further local taxes can be imposed.

Representation on Local Authorties.

The Committee regret to record the general apathy of industrialists, which has prevented them from serving on local authorities or encouraging their staffs to do so. They are glad to note that in certain parts of the country a greater interest in municipal affairs is being taken by industrialists, and trust that this movement will spread. They cannot but feel that the experience of business men should be of the greatest advantage in municipal work, and that much extravagance in the past can be traced to the ignorance of business principles shown by the administrators. The Committee do not wish to suggest that industrialists or the staffs of industrial firms should serve upon local authorities as delegates of industrial interests or in any other capacity than as citizens, but they desire to record their conviction that heads of firms who will themselves serve upon municipal councils or will encourage suitable members of their staffs to do so will be performing a public service of the greatest importance.

ARGENTINA—EXHIBITION OF EDUCATIONAL MATERIALS.

The Department of Overseas Trade is informed by the British Legation at Buenos Aires that the American Academy of History (President, N. Sarmiento) is organising an International Congress of History and Geography of America and Exhibition of Educational Materials, to be held in Buenos Aires in 1924.

The Academy invites all scientific and geographical institutions to participate, as well as manufacturers of and dealers in materials concerned in the supply of educational institutions, libraries, science laboratories, etc.

If the project is of interest to United Kingdom institutions or firms, further particulars of the scheme may be obtained from the Secretary of the Academy, Dr. A. E. de la Guardia, Academia Americana de la Historia, Buenos Aires.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE CHEMICAL SOCIETY.

Papers read at the Ordinary Meeting on December 20:—

The Relation between the Glow of Phosphorus and the Formation of Ozone, by W. E. Downey.

The amount of ozone produced in the slow oxidation of phosphorus was shown to be proportional to the intensity of the glow. Oxygen was led at varying pressures over phosphorus, the oxides of phosphorus formed were frozen out, and the ozone was absorbed in a solution of potassium iodide. The intensity of the glow was measured

photographically. The light of the glow, after passing through a quartz or fluorite window, was shown to ozonise oxygen. The oxidation of phosphorus trioxide was accompanied by the formation of ozone; and the glow was also capable of ozonising oxygen. The glow was shown to be capable of ionising air, and must therefore contain light of the region $\lambda = 1200-1800$ A.U. The fact that the glow extends into this region gives a possible explanation of the formation of ozone and ions found in the presence of glowing phosphorus.

The Origin of Mutarotation and the Mechanism of Isomeric Change. A Reply to Baker, Ingold, and Thorpe, by T. M. LOWRY.

The view that water does not intervene in the mutarotation of sugars was criticised on the grounds that it is not in accordance with experimental data, and that the method of proof based upon the form of the mutarotation curves was not valid.

The Action of Inorganic Haloids on Organo-Metallic Compounds, by F. CHALLENGER and F. PRITCHARD.

The interaction of the triphenyl derivatives of phosphorus, arsenic, antimony and bismuth with the corresponding trihaloids in ethereal solution has been studied at ordinary or slightly elevated temperatures, to determine whether the reactions largely depended on solubility factors, or if definite rules could be discovered which govern the migration of phenyl groups from one element to another.

With triphenylbismuthine and various haloids, sparingly soluble diphenylchloro bismuthine, $Ph_2Bi\ Cl$, is produced:

$$Ph_3Bi + P\ Cl_3 = Ph_2Bi\ Cl + PhPCl_2.$$

Similar results were observed by Goddard and others, with the tetraphenyl derivatives of tin and lead.

A similar, though weaker, tendency is observed with triphenylarsine, though partly obscured by the formation of additive products. Thus, with antimony trichloride, some phenyldichloroarsine, $Ph\ As\ Cl_2$, is produced, and also an additive product giving the arsine and antimony oxychloride with water.

With triphenylphosphine the tendency for migration of the phenyl group has almost disappeared, additive products always resulting. These undergo an interesting decomposition on heating, giving rise to the free metal, and presumably, to Ph_3PCl_2, which, with water, gives triphenylphosphine oxide, Ph_3PO. This holds for the haloids of phosphorus, arsenic, and bismuth, and, to a much smaller extent, of antimony, no phosphine oxide being isolated in this case. Phosphorus trichloride is only reduced to a subchloride. When triphenylstibine interacts with metallic haloids these are also reduced and triphenylstibine dichloride formed. Migration of the phenyl group occurs but rarely.

The difference in the behaviour of the phosphine and stibine from that of triphenylbismuthine may possibly be explained on the assumption that the last-named compound is slightly ionised in ether, whereas the others are much less ionised. However, the work of Hevesy and Zechmeister (*Ber.*, 1920, LIII., 410) appears to show that tetraphenyl plumbane, $PbPh_4$, is not ionised in pyridine or amyl alcohol.

Organo-Derivatives of Bismuth. Part VII.: Iodo- and Nitro-Derivatives of Triphenylbismuthine, by J. F. WILKINSON and F. CHALLENGER.

Interactions between triphenylbismuthine and iodine and cyanogen haloids have been further investigated. It has been shown that triphenylbismuthine di-iodide, $(C_6H_5)_3BiI_2$, exists at low temperatures, but immediately decomposes in ethereal solution at room temperature. At ordinary temperatures, triphenylbismuthine and iodine yield diphenyliodobismuthine and phenyldi-iodobismuthine in varying proportions. Additive compounds of triphenylbismuthine and cyanogen haloids were not formed, the products being diphenylchloro-bismuthine, diphenylbromo-bismuthine, and benzonitrile with cyanogen chloride and bromide respectively, whilst cyanogen iodide yielded diphenylcyanobismuthine and iodobenzene. Cyanogen iodide reacts readily in dry ether with the triphenyl-derivatives of phosphorus, arsenic, and antimony, forming primarily the iodocyanides, which immediately decompose with traces of moisture, yielding hydrogen cyanide and the oxide (of triphenylphosphine) and hydroxyiodides (of the triphenyl-derivatives of arsenic and antimony) respectively. Attempts to nitrate triarylbismuthines, with the object of determining the directing influence of the bismuth atom towards substituents, have failed, benzoyl nitrate giving only the respective bismuthine dinitrates, whilst acid

reagents completely disrupt the molecule with the production of *m*-dinitrobenzene. Derivatives of quinquevalent bismuth, however, are readily nitrated, giving more or less stable meta-nitro-triphenylbismuthine dinitrates, which yield crystalline dihaloids. Of these compounds, the tetranitrated derivatives appear the most stable. The dichloride yields the corresponding dihydroxide, a stable compound of a type which hitherto has not been prepared: treatment of this with hot alcohol furnishes trinitrotriphenylbismuthine.

THE ROYAL INSTITUTION OF GREAT BRITAIN.

The subsequent Christmas Juvenile Lectures arranged by the Royal Institution, entitled *Concerning the Nature of Things*, by SIR WILLIAM BRAGG, are as follows:—

II.—Saturday, Dec. 29: *The Nature of Gases.*

III.—Tuesday, Jan. 1: *The Nature of Liquids.*

IV.—Thursday, Jan. 3: *The Nature of Crystals: Diamond.*

V.—Saturday, Jan. 5: *The Nature of Crystals: Ice and Snow.*

VI.—Tuesday, Jan. 8: *The Nature of Crystals: Metals.*

Lecture hour: 3 o'clock.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Wireless Section will hold a meeting on Wednesday, January 2, at 6 p.m. when a paper entitled *Some Experiments on the Screening of Radio Receiving Apparatus* will be read by R. H. BARFIELD, M.Sc., student.

THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

The proceedings at the Monthly Council on Wednesday, December 12 (Lieut.-Col. E. W. Stanyforth, President, in the chair), included, among other matters, the presentation of the following report of the Chemical Committee:—

CHEMICAL.

Mr. J. L. Luddington (Chairman) reported that Dr. Voelcker had presented the list of samples analysed by him during the month of November. The Annual Report of the Consulting Chemist had been considered by the Committee and passed for publication in the next volume of the Journal. The Chairman had reported that he had attended and given evidence before the Departmental Committee on the Fertilisers and Feeding Stuffs Act. Dr. Voelcker had reported on several matters arising out of his correspondence. These dealt with inferior cotton cake, basic slag which was adulterated with ground phosphate, and African phosphate which was insufficiently ground and consequently practically useless. The Leaflet giving particulars of the cases reported at the November meeting of the Committee had been circulated to all the Governors and Members with the report of the Council to the annual general meeting.

The Committee estimated that for the ensuing year their expenditure would amount to £400, plus the amount of the Laboratory petty cash.

The Committee had met eight times and had made eight reports during the year.

ELECTROLYTIC PRODUCTION OF ACTIVE HYDROGEN.

BY Y. VENKATARAMAIAH AND BH. S. V. RAGHAVA RAO.

[*From the "Journal of the Science Association, Maharajah's College, Vizianagaram.*]

Attempts at the preparation of "active hydrogen"—

(i) by the electrolysis of solutions of electrolytes;

(ii) by the action of acids on metals, by Y. Venkataramaiah (*Proc. Sci. Assoc., Maharajah's College, Vizianagaram, July* 10, 1921, p. 2). Wendt and Landauer (*J. A. C. S.*, Vol. XLIV., No. 3, p. 513), ended in a failure. Wendt and Landauer describe reasons for their failure thus:

"We are here between two experimental difficulties. The hydrogen must be evolved so rapidly that it reaches the sulphur within a minute, to avoid the decomposition of the active form into the ordinary. On the other hand, if evolution is made rapid, the gas carries with it large amounts of spray which are practically im

possible to remove without slowing up the stream of gas more than can be allowed. . . Hence the sulphur may well have become coated with a film of moisture which prevented the access of the active hydrogen."

The authors have now repeated the experiments, using a slightly different experimental technique from that of the American chemists, and found the possibility to demonstrate the presence of active hydrogen in electrolysis. Wendt and Landauer have shown (*J. A. C. S.*, Vol. XLII., No. p. 937), that nitrogen combines directly with active hydrogen to form ammonia. Taking advantage of this fact, the authors set up an electrolytic cell with platinum electrodes, one of the electrodes being a small platinum tube of length 30 mm. and of internal diameter 1.0 mm. and external diameter 1.5 mm. It is perforated with a number of pin-holes. A current of 3 to 15 amperes is employed to electrolyse a dilute solution of sulphuric acid. During the course of electrolysis a current of pure nitrogen is sent through the perforated electrode into the solution. The nitrogen combines with the active hydrogen liberated during the course of the electrolysis to form ammonia, and the ammonia is fixed as ammonium sulphate. After a run of about 12 hours the electrolytic liquid, on treatment with alkali, gives unmistakable tests for the presence of ammonia. Similar is the case with caustic potash solution.

To confirm the results obtained above, a second series of experiments is undertaken, in which the permeabilit yof iron to nascent hydrogen at ordinary temperatures is utilised. For this purpose an iron tuhe 30 cms. long and 12 mm. diameter, closed at one end, is fixed in a tube provided with a nickel electrode and containing water acidulated with sulphuric acid. The iron tube is connected to a glass bulb containing cold powdered sulphur, which in its turn is connected to a small glass bulb packed with glasswool. This again is connected to a small glass bulb containing a lead-acetate paper kept moist by dipping in a solution of the acetate. This bulb is finally connected to a rotating exhaustion pump. During electrolysis the iron tube is made the anode and the pump is kept running. Atomic hydrogen which diffuses through the iron tube yields a little triatomic hydrogen. This combines with sulphur to form hydrogen-sulphide as indicated by the blackening of lead acetate paper in a few hours.

In this connection the authors propose the following simple device for lecture demonstrations, to show the production of triatomic hydroge nduring electrolysis. A long glass tube, about 150 cms. long, provided with a small iron cup at one of the ends, is filled with mercury and inverted over a trough of mercury. About 1 cc. of pure nitrogen is then sent into the Torrecelian vacuum. Acidulated water is next poured into the cup and the water electrolysed, making the cup the anode. After a time a few ccs. of Nessler's reagent introduced into the vacuum show a distinct brown colouration indicating the presence of ammonia in the tube.

Preliminary experiments conducted show that the failure in the experiments of Wendt and Landauer is to be ascribed not only to the protective coating that the spray forms on sulphur, but also to its distinct chemical action on active hydrogen with the formation of hydrogen peroxide and molecular hydrogen. The reaction may be represented thus:—

$$2\ H_3 + 2\ H_2O = H_2O_2 + 4\ H_2.$$

Research Laboratories,
H.H. The Maharajah's College,
Vizianagaram.

CORRESPONDENCE.

COSMISM.

To the Editors of THE CHEMICAL NEWS.

SIRS,—Mathematico-physicists as a body, rather than tbe individual as thinking unit, have decided that the fourth dimension of space is a legitimate conception, and that the space-time velocity of light is the only rigid constant. Nevertheless, time is simply a ratio of macrocosmic and microcosmic inertia; so that space is timeless and Euclidean, and no ethereal substance exists other than the unit of inertia which is the atomic constant of both matter and energy.

The shape of nuclear atoms, having a Proutian unit half that of hydrogen, was published in 1897[1] contemporaneously with the orthodox electrical theory of matter and the quantum theory. A definite relationship between such shape and the combining capacity of carbon nitrogen and oxygen unexpectedly emerged, and was published in 1900[2] and again in 1913[3]

Torricelli weighed the atmosphere and Boyle measured its elasticity; but such materialistic results were rejected for forty years. The ether likewise can be weighed, its elasticity measured, and its electrons counted. When Sir Ernest Rutherford shattered the atomic nucleus of nitrogen, the real subatomic unit should have been revealed. It had $\sqrt{2}$ times the velocity for hydrogen, corresponding to a mass unit of one-half, but a crucial experiment is awaited to settle this problem. Likewise, positive ray parabolas with half the normal energy of hydrogen were obtained in 1919, but unwarranted assumptions bolster up the electrical theory of matter.

The identity of ordinary mechanical mass and electrical mass is responsible for much confusion of thought, but an atomic ether solves the problem.

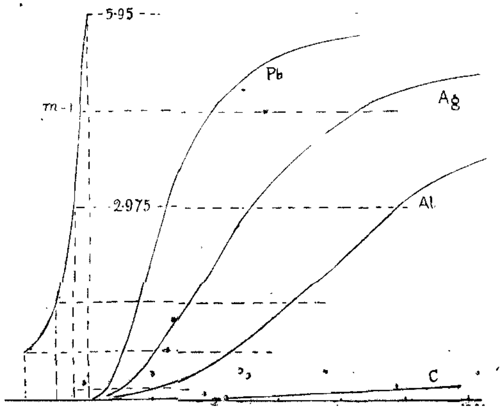
The ether is a perfect atomic fluid, in which the structural loss of an atom forms the Osborne-Reynolds electron, which can be intermolecular only. Atomic numbers represent potential electrons formed endothermically from kinetic electrons by subatomic aggregation at stellar temperature. Planetary gravitational vortices are immutable and indestructible in such perfect fluid. A positive ether pressure (0.5×10^{24}) deduced from $c^2 = p/d$ and $R^2 = D/d$, where $c = 3 \times 10^{10}$, while $R = 2.46$ the refractive index, and $D = 3.5$ the density of diamond, but such should be determined at zero, carries the negative quanta[4] dynamics of electron propagation through the ether structure by a virtual longitudinal pulse, producing the concentrated photo-electric or photo-chemical effect as a molecular phenomena. The pressure, p, operates the inverse Osborne-Reynolds electron repulsion, or total inductive capacity, usually denoted by K, while the magnetic permeability, u, is identical with the density, d.

The molecular-heat equation published in 1920[5] is unintelligible to a physicist accustomed to an electrical atom. The simple form of that equation is

$$k = m \quad \log T \qquad (1)$$

where k and x are constants for any given *element or compound at constant volume.* The single dependent variable, m, representing the physical and chemical association, which is the number of atoms or radicles per molecule, dissipates all the mystery associated with chemical force, as an aspect of entropic force, by showing that the number of atoms or radicles per molecule varies as a simple inverse function of the temperature, and that there is a positive entropic force producing condensation, crystallisation, or solidification, on the one hand; and a negative entropic force producing temperature *(and expansion)* on the other.

With mixtures of chemical elements whose combining capacity is a function of atomic shape, catastrophic ejection of electrons is liable to occur corresponding to the change of state whenever the temperature approaches the specific value relative to any



integral value of m; but the association m is a purely physical or bulk effect, and not a chemical attraction within the field of the atom.

The agreement of equation (1) with the Nernst specific heat curves (obtained by inserting the freedom equation of *m*, whose graph is given on the left of Fig. 1) proves that temperature is due to molecular vibration only, and that atomic motion at low temperature is not heat. Therefore a *kinetic "Stokes" ether of Proutian sub*atoms, even with an intrinsic pressure greater than that of solids, to carry the infinitely large negative stresses of gravitation, or the infinitesimal light-quanta, is frictionless. It follows that stresses in the rigid subatom are not heat, notwithstanding Lord Kelvin's dictum.

One dyne per square centimetre is a positive or negative ethereal pressure of 300 volts. The intrinsic pressure of all solids at *the absolute zero is equal to the ethereal* pressure of eighty-billion tons per square inch.

Will chemistry, and especially photochemistry,[6] indefinitely accept Bohr's physical interpretation for fact when chemical forces with physical expansion and contraction are proved by equation (1) to be the entropic pressures of the ether? Van't Hoff took the work obtainable in the evaporation of unit mass as a measure of the chemical affinity, which is thus a function solely of volume, temperature, and atomic mass.

At higher temperatures increasing electrons separate the concomitant molecules and produce a negative ethereal pressure, or voltage, or vapour pressure, which reduces the intrinsic pressure with its molecular surface-tension until, at a specific temperature, the intrinsic pressure becomes identical with the vapour pressure, so that the molecular surface-tension is zero.

Yours, &c.,
FRED G. EDWARDS.

171, *Roundway,*
Waltheof Gardens, N.17.
November 17, 1917.

References to author's publications:—

[1] *Specn. of Letters Patent No.* 1999, A.D. 1897.
[2] *Chemistry, J. and A. Churchill,* 1900.
[3] *Engg Mech., July* 18, 1913 *(illus.).*
[4] *Engineering, Nov.* 24, 1916 *(illus.).*
[5] *Chem. News,* CXX., 277, *June* 11, 1920.
[6] *Chem. News,* CXX., 292, *June* 18, 1920.

NOTICES OF BOOKS.

The Principle of Relativity: A Collection of Original Memoirs on the Special and General Theory of Relativity, by H. A. LORENTZ, A. EINSTEIN, H. MINKOWSKI and H. WEYL, with a note by A. SOMMERFELD; *being translated from the German* by W. PERRETT and G. B. JEFFERY. Pp. VIII. + 216. 1923. Messrs. Methuen & Co., Ltd., 36, Essex Street, London, W.C.2. 12s. 6d. net.

Science advances by means of two main conveyances, viz.: the pantechnicon van with a driving mechanism of a highly complex type, and the plain horse and cart that requires no very special skill to manipulate. This book shows the development of the former method, and it is of necessity highly *mathematical.* The pantechnicon affords a more elegant means of transportation, but *it does not* necessarily hide worn-out pieces of furniture. The similes are poor, but they will have to suffice.

The readers of these foundation papers, for the most part put into English from the German by the labours of G. B. Jeffery and W. Perrett, will, of course, bear in mind that some developments have been made in the science of relativity since these papers were written; and, as a result, here and there the views expressed require readjustment.

Notwithstanding, all who are able to delve in this highly mathematical subject should possess this work and study the original methods of exposition.

To the average student of physics many statements appear which will be appreciated if he is seriously interested in the subject. Relativity needs no introduction, so we have contented ourselves with a few selections from the text, which will no doubt be seized upon as gems from the classics.

LORENTZ, 1895.—In the Michelson experiment, "a shortening in the direction of motion in the proportion of 1 to $\sqrt{1-v^2/c^2}$, in accordance with the formulæ given in the above-mentioned paragraph."—p.7.

EINSTEIN, 1905.—"So we see that we cannot attach any *absolute* signification to the concept of simultaneity, but that two events which, viewed from a system of coordinates, are simultaneous, can no longer be looked upon as simultaneous events when envisaged from a system which is in motion relatively to that system."—p. 42.

EINSTEIN, 1905.—"*The laws by which the states of physical systems alter are independent of the alternative, to which of two systems of co-ordinates, in uniform motion*

of parallel translation relatively to each other, these alterations of state are referred (principle of relativity)."—p. 69. We think that this sentence is not crystal clear, as H. G. Wells would doubtless express it.

"The kinetic energy of the body with respect to the [other bodies] ξ, η, ζ, diminishes as a result of the emission of light, and the amount of diminution is independent of the properties of the body."

Moreover, the difference $K_0 - K_1 = \frac{1}{2}\frac{L}{c^2}v^2$.

"From this equation it directly follows that: *If a body gives off the energy* L *in the form of radiation*, its mass diminishes by L/c^2. The fact that the energy withdrawn from the body becomes energy of radiation evidently makes no difference, so that we are led to the more general conclusion that the mass of a body is a measure of its energy content; if the energy changes by L, the mass changes in the same sense by $L/9 \times 10^{20}$, the energy being measured in ergs, and the mass in grammes.

"It is not impossible that with bodies whose energy content is variable to a high degree (*e.g.*, with radium salts) the theory may be successfully put to the test [see Richardson's statement given in *The Chemical News*, 1915, Vol. CXII., page 261].—p. 71.

"If the theory corresponds to the facts, radiation conveys inertia between the emitting and absorbing bodies."

MINKOWSKI, 1908.—This paper contains in its opening paragraph the famous statement about time and space, which we have italicised: "The views of space and time which I wish to lay before you have sprung from the soil of experimental physics, and therein lies their strength. They are radical. *Henceforth space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality.*"—p. 75.

"I will state at once what is the value of *c* with which we shall finally be dealing. It is the velocity of the propagation of light in empty space. To avoid speaking either of space or its emptiness, we may define this magnitude in another way, as the ratio of the electromagnetic to the electrostatic unit of electricity."—p. 79. Following Minkowski's paper are Notes thereon by A. Sommerfeld.

EINSTEIN, 1911.—"One result yielded by the theory of relativity is that the inertia mass of a body increases with the energy it contains; if this increase of energy amounts to E, the increase in inertia mass is equal to E/c^2, when *c* denotes the velocity of light. Now, is there an increase of gravitating mass corresponding to this increase of inertia mass? If not, then a body would fall in the same gravitational field with varying acceleration according to the energy it contained. That highly satisfactory result of the theory of relativity by which the law of the conservation of mass is merged in the law of the conservation of energy could not be maintained, because it would compel us to abandon the law of the conservation of mass in its old form for inertia mass, and maintain it for gravitational mass.

"But this must be regarded as very improbable. On the other hand, the usual theory of relativity does not provide us with any argument from which to infer that the weight of a body depends on the energy contained in it. But we shall show that our hypothesis of the equivalence of the systems K and K′ gives us gravitation of energy as a necessary consequence."—p. 101.

EINSTEIN, 1917.—"The opinion I entertained until recently, as to the limiting conditions to be laid down in spatial infinity, took its stand on the following considerations. In a consistent theory of relativity there can be no inertia *relatively to 'space*,' but only inertia of masses *relative to one another*. If, therefore, I have a mass a sufficient distance from all other masses in the universe, its inertia must fall to zero. We will try to formulate this condition mathematically."—p. 180.

WEYL, 1918.—"According to Einstein the phenomena of *gravitation* must also be placed to the account of geometry, and the laws by which matter affects measurements are no other than the laws of gravitation."—p. 202.

The reviewer wrote in 1894, as a note against a paragraph on motion in a book published the same year, the following:—"Knowledge is fundamentally *relative;* even our knowledge of physical facts and, moreover, finite deductions can be made when using infinite postulates, and here again we find the principle of *relativeness*. We cannot get away from it, nor should we attempt to." It will be seen from a study of this book how vague ideas, such as this example illustrates, have been crystallised into harmonious form by a powerful mathematical treatment.

In conclusion, the publishers are to be

congratulated on the enterprise shown in placing before relativity students such a monumental work.

Jacob Green, 1790-1841, Chemist, by E. F. SMITH. Pp. 34. 1923.

Jacob Green was a quiet, persevering, and enthusiastic American scientist, whose retiring nature prevented his name from being as well known as his attainments justified.

Prof. Smith, of the University of Pennsylvania, has now published a little biographical sketch of Green, which should be an inspiration to the young chemists of today.

The British Journal Photographic Almanac, 1924, Edited by GEORGE E. BROWN, F.I.C. Pp. 812. London: Henry Greenwood & Co., Ltd., 24, Wellington Street, Strand, W.C. Paper covers, 2s.; bound, 3s.

The B.J. Almanac for 1924 fully maintains the high reputation established by its predecessors.

In addition to the valuable and complete data concerning the various photographic processes and apparatus, it also includes a very practical article by the Editor, entitled, *Using a Hand Camera*, and an epitome of progress in the subject during the year.

This *Epitome of Progress* constitutes a valuable record of the scientific work accomplished by photographers. Whilst no research of outstanding importance has appeared during the past year, it is noteworthy that steady progress has been maintained in the solution of the problems of photography, especially in regard to lenses and in colour photography.

As a reference volume, the B.J. Almanac is replete with such information as tables (which have been revised) of weights and measures, chemical and physical constants, etc. There is also a useful trade directory.

Chemists who are also photographers should find the Almanac indispensable.

BOOKS RECEIVED.

A Course of Laboratory Experiments on Physico-Chemical Principles, by WILLIAM C. BRAY and WENDELL M. LATIMER. Pp. X. + 120. 1923. The Macmillan Company, New York, U.S.A.

Dangerous Goods, by DR. JULES ABBY. Pp. XI. + 319. 2nd Edition. 1922. Messrs. Crosby Lockwood & Son, 7, Stationers'

New Patents.

THIS list is specially compiled for *The Chemical News* by Messrs. Rayner & Co., Registered Patent Agents, of 5, Chancery Lane, London, from whom all information relating to Patents, Trade Marks, and Designs can be obtained gratuitously.

Latest Patent Applications.

29800—Coke, B. E.—Oxidation of naphthalene, etc. Nov. 27.
29801—Coke, B. E.—Oxidation of aromatic hydrocarbons. Nov. 27.
29972—Mathieson Alkali Works, Inc.—Manufacture of hypochlorites. Nov. 28.
29737—*Stevenson, W. J.—Manufacture of acetyl cellulose.* Nov. 26.
30438—Atkinson, R. G.—Apparatus for chemical action under the influence of light. Dec. 4.
30726—Guadagni, G.—Manufacture of acids. Dec. 6.
30535—Lichtenthaeler, F. E.—Process of concentrating aqueous solutions of volatile *substances.* Dec. 4.
30805—Stokes, J. S.—Synthetic resins. Dec. 7.

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207267—Paterson, W.—Apparatus for treating liquids with chemical reagents.
199743—Guilleminot, P. L.—Sulphonation of fatty *substances of animal origin.*
207476—Soc of Chemical Industry in Basle.—Manufacture of vat dyestuffs derived from anthraquinone.

Abstract Published this Week.

205563—Aluminium chloride, alumina.—Chemische Fabrik Griesheim-Elektron, of 51, Gutleutstrasse, Frankfort-on-Main, Germany.

Aluminium chloride; alumina.—An aluminium chloride solution which may be obtained by treating calcined clay with hydrochloric acid (or with aluminium chloride solution enriched with hydrochloric acid) *is evaporated to produce a crystal* sludge from which mother liquor is separated. The crystals are washed with hydrochloric acid or first with some of the original solution, and then with pure hydrochloric acid (for instance of 20 per cent. strength), the mother liquor and washings being used to absorb hydrochloric acid arising from the calcination of the crystals to *obtain alumina (when such calcination is effected)* or from other sources, and used according to their content of iron either for washing the crystals or for treating more clay. When the solutions accumulate too much iron they are evaporated and calcined to produce hydrochloric acid.

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